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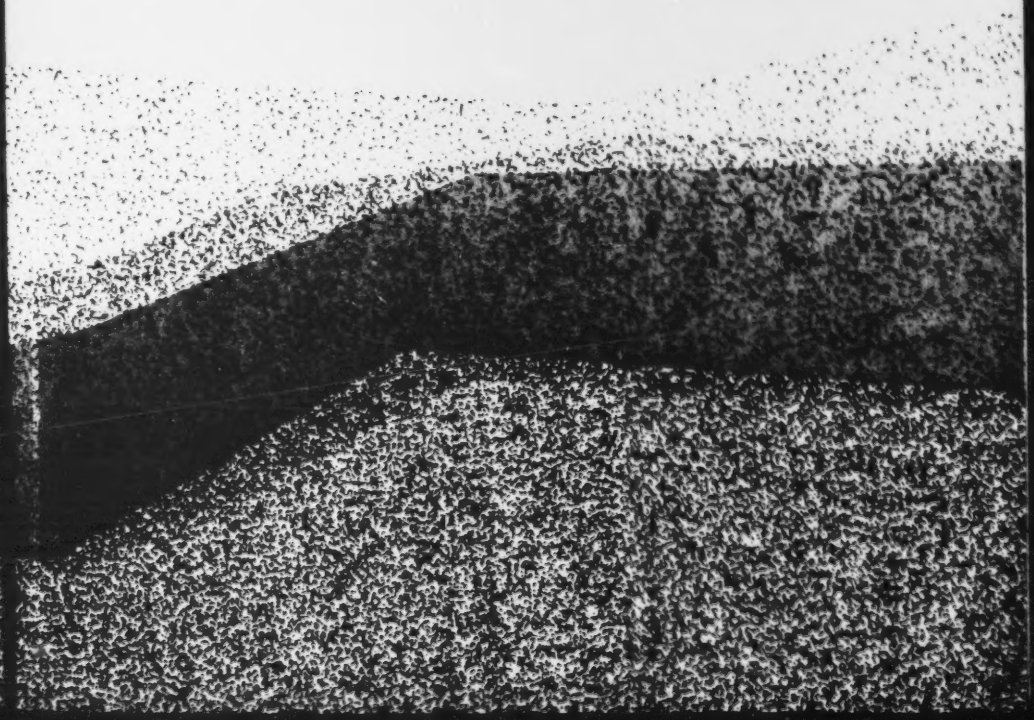
Queen's University
Kingston, Ontario

Structural Changes in the World Mineral Industry: Implications for Canada

Proceedings No. 18

Edited by
M.J. WOJCIECHOWSKI



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STRUCTURAL CHANGES IN THE WORLD MINERAL INDUSTRY: IMPLICATIONS FOR CANADA

Proceedings of the
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September 9-11, 1985
Kingston, Ontario

Edited by

M.J. Wojciechowski

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FOREWORD

This volume contains the proceedings of the 15th CRS Policy Discussion Seminar. The CRS seminar series brings together individuals from industry, governments, labour, universities, and other organizations to share their knowledge and views on selected issues in mineral policy.

Structural changes over the last decade or so have profoundly and permanently changed both supply and demand patterns in world mineral markets. The seminar looked at these changing patterns, both in general and for several specific commodities, discussed related economic, trade and currency-related issues, and identified strategic responses which have been taken and might be taken in future to assist the Canadian mineral industry in adjusting to the new circumstances.

The seminar was held at the Donald Gordon Centre for Continuing Education in Kingston on September 9-11, 1985. The program was arranged by Peter Richardson of Queen's University School of Business, in consultation with CRS. The proceedings volume was edited by Margot Wojciechowski and produced by Donna Beaubien.

The Centre is grateful for the contributions of the speakers and participants, both during the seminar and in the preparation of the proceedings. Views expressed are those of individual participants, and do not necessarily represent the views of the Centre or its sponsors.

Margot J. Wojciechowski
Centre for Resource Studies

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STRUCTURAL CHANGES: IMPLICATIONS FOR CANADA

Major changes have taken place in the structure of the world's mineral industries which have significant implications for the mining industry in Canada. While there is considerable work in process to measure these changes and understand their impact, the problem is far from being well understood. The purpose of this CRS Policy Discussion Seminar was to further understanding of the process which is under way, and develop policy recommendations which will enable Canada to meet the challenges effectively and to take advantage of opportunities arising from these changes.

Papers and discussions in the first part of the seminar dealt with changing patterns of supply and demand. Demand for many minerals is being affected by declining growth rates in existing markets and substitution by new materials. New markets, often with substantially different requirements and product characteristics, are emerging. Accompanying these demand changes are altered patterns of supply. Structural shifts are taking place in the world mineral industry which challenge Canada's position as a leading producer of many mineral products. Case studies of lead and zinc as well as potash cite specific industry examples of these challenges and their impact.

The structure of Canada's mining industry in the future will be, to a great extent, determined by the general economic climate. In the second part of the seminar, papers were presented addressing the general economic outlook for mining, trade policy, and the impact on the industry of currency fluctuations. In the United States, these factors have combined to play a key part in the recent decline of the mining industry in that country. Given the high export orientation of Canada's mining industry, these factors will play a key role in determining its future structure and share of world mineral trade.

The final part of the seminar presented alternative views of what actions might be taken to adapt to these structural changes. Papers were presented by federal and provincial governments, as well as private sector representatives. In addition participants brought forward their own experiences and views in a final plenary session and throughout the seminar, and these are restructured and summarized in the digest of discussions. A closing summary was provided by Keith Buck, former Secretary-General of the International Lead and Zinc Study Group, who has had substantial practical experience in dealing with structural change in this key industry.

KEYNOTE ADDRESS: STRUCTURAL CHANGES IN THE WORLD MINERAL INDUSTRY: IMPLICATIONS FOR CANADA

Phillip Crowson

Introduction

It is worth starting with a question of semantics: what, precisely, is meant by structural change? The phrase is often used to distinguish some kinds of change from the cyclical developments which are regarded as reversible features of the business cycle. Does this mean that we are discussing changes which are likely to prove permanent? Some changes which have been treated as structural will in time be reversed, so that we may be merely talking of long-run rather than short-run cyclical movements. Of course, a terminally ill patient, as much of the mining industry presently seems to be, may not be too interested to know that his condition is only temporary, when its conclusion is likely to be his demise. Yet we have to recognize that mining has always been a dynamic industry, as the grassed-over spoil heaps and ghost towns of abandoned mining areas throughout the world bear witness. Change has always been a feature of the mining business. Economists distinguish between cyclical and secular trends, the latter being defined as "those continuing over vast periods of time". Many of the recent changes in the mining industry, which have been described as structural are in truth secular. Other changes which may have appeared to be very sudden may not be genuinely structural in nature.

These questions, which could be multiplied almost ad infinitum, are highly relevant to this seminar. A failure to diagnose changes correctly may well lead to faulty prescriptions. In any case, this paper will concentrate on structural changes in the world mining industry rather than on their implications for Canada. Perhaps these implications can be summed up very briefly in Adam Smith's remarks over two centuries ago about the world always beating a path to the door of the man who builds a better mousetrap.

The roots of the mining industry's present difficulties lie in the extraordinarily sustained post war economic boom. This historically atypical period of 25 years of rapid economic growth without serious cyclical disturbances engendered firmly held beliefs about the inevitability of

progress. Exchange rates were reasonably stable under the Bretton Woods System, and world trade flourished as the controls of the 1930s and 1940s were progressively dismantled. An entire generation of managers and officials grew up who had never experienced different economic conditions. Investment plans were formulated in the confident expectation of continued growth, virtually underwritten by governmental policies. There might be the occasional pause but it would be only temporary, and it would be relatively easy to pass on cost increases in higher prices.

The devaluation of the U.S. dollar in 1971, the cyclical excesses of 1972-74 and the rise in oil prices associated with the Yom Kippur war severely dented expectations but did not dispel them. It was recognized that the world economy had suffered a series of shocks, and that growth might be temporarily delayed, but it was widely believed that normal service would be resumed relatively quickly. The last decade has seen harsh reality intrude on those illusions, which no doubt most of us shared in varying degrees.

Demand for Metals

Much has been written on some of the changes on the demand side of the minerals industry, but the comment appears to concentrate on the symptoms rather than the causes. Thus falling "intensity of use" is trotted out with monotonous regularity, and to the point where even Australian cabinet ministers can authoritatively quote the Japanese phrase "Kei Haku Tan Sho", or "lighter, thinner, shorter, smaller". It bears repeating that intensities of use of most metals have fallen in the developed countries for many years. Recent experience is by no means out of step with historical trends. Consider copper, for instance. Particularly in the United States there is some evidence of cyclical variation around a generally declining trend; a trend that has been in existence for many years. Other metals, by and large, show similar patterns.

By themselves, studies of intensity of use are descriptive rather than diagnostic. It is therefore worth going behind the figures in more detail. One of the major statistical weaknesses of the worldwide minerals industry now arises. This is the lack of regular, accurate and comprehensive data on the ultimate end uses of the individual metals. Without such data it is difficult to track exactly how demand has moved in the past and how it might change in the future. Table 1 is based solely on some fairly rough and ready estimates for the United States.

Table 1

UNITED STATES' DOMESTIC CONSUMPTION OF METALS BY END USE 1979 & 1984
(percentages)

	Aluminium		Copper[a]		Iron & Steel		Lead		Nickel		Zinc	
	1979	1984	1979	1984	1979	1984	1979	1984	1979	1984	1979	1984
Building & construction	24	18	18	34	27	31	3	3	9	10	40	45
Electrical	11	9	58	24			2	2	13	11	12	9
Machinery & equipment			9	16	20	19			7	7	10	11
Transport	22	20	9	12	31	27	73	75	24	24	26	25
Consumer durables	8	8				7			7	8		
Packaging	23	35			6							
Other uses	12	10	6	14	16	16	22	20	40	40	12	10
Total Consumption '000 tonnes	5,341	5,330	2,433	2,100	121.6[b]	99.3[b]	1,259	1,030	205	204	929	1,030

Source: Mineral Commodity Summaries 1980 and 1985.
Note: blanks denote no information given and included in other uses.
[a] Definitions apparently altered between 1979 and 1984, with the electrical demand being re-allocated in 1984.
[b] million tonnes.

These are not entirely representative of the world as a whole, but they do bring out some important points. Demand for lead is dominated by the transport sector specifically for batteries and gasoline additives. Transport is also a major consumer of the other metals, except copper. Demand for aluminium is biased towards consumption, more so in the USA where packaging outlets are more important than elsewhere. Capital expenditure is the main determinant of demand for copper, iron and steel, and zinc, and probably of nickel were the allocation of end uses carried out properly. This dependence on investment and the transport sector provides a structural explanation of changes in demand for metals, an explanation that is more intellectually coherent than the sudden change in consumers' behaviour implied by many of the arguments about substitution and miniaturization.

The Behaviour of Investment

Here we enter another statistical minefield, in that few comprehensive historical data are regularly published on total capital expenditure, let alone forecasts. The main economic consulting firms often do not give figures for individual countries, let alone totals. It is clear that expenditure on investment has lagged behind consumer spending in the past decade, and that it has accounted for a diminishing portion of the OECD's total gross domestic product. Figure 1 compares the behaviour of real GDP and investment (gross fixed capital formation) in the OECD Area since 1970.

The latter's share of GDP dropped to 19.7 percent in 1983, the lowest overall share for at least twenty years. The fall was especially pronounced in the United States.

Going beyond the totals gives the picture shown in figure 2. Remember that building and construction figure prominently as major outlets for several metals.

Full details of 1984's spending are not yet available, except for residential construction. Expenditure on machinery and equipment, which includes vehicles of all types, is much higher now than in the early 1970s' boom. Much of this spending has been on cost cutting of all types and on enhancing productivity rather than on expanding capacity. In short, it has gone into equipment with high value added rather than into metals-intensive plant. The contrast with spending on construction, and especially on the nonresidential variety, is marked. These have clearly suffered from the slowdown of economic growth since the early 1970s.

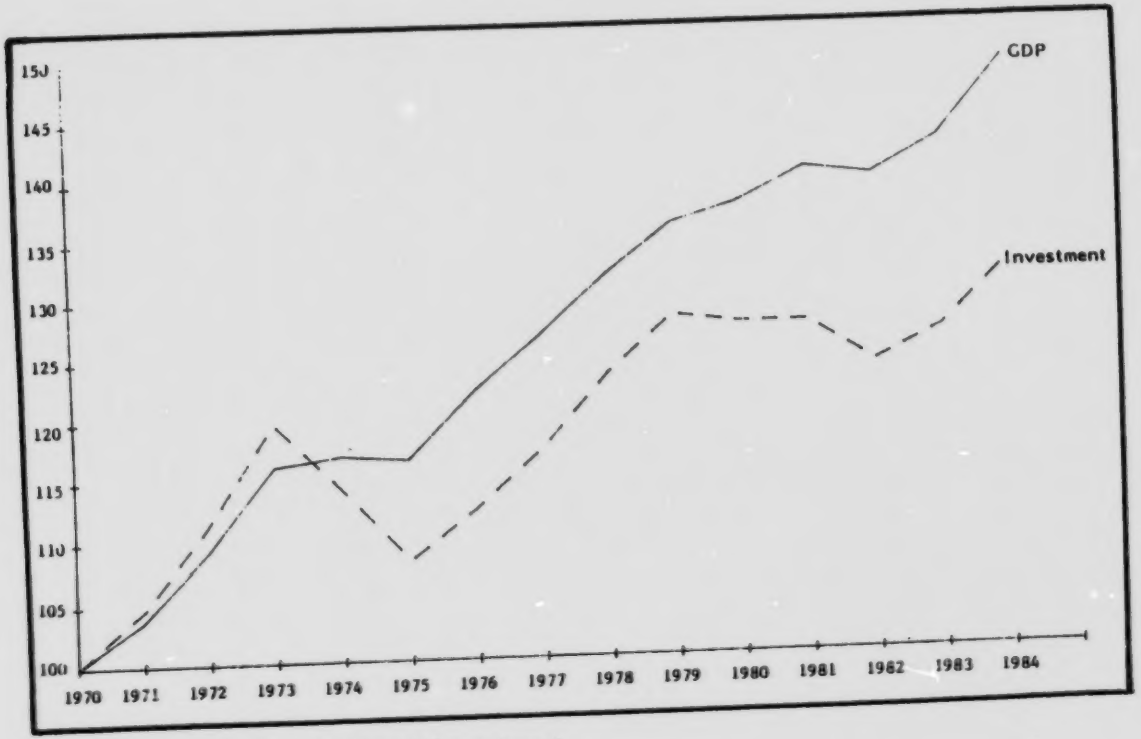

Figure 1. OECD Real GDP and Investment (index numbers 1970=100)

Source: OECD Historical Statistics 1960-83

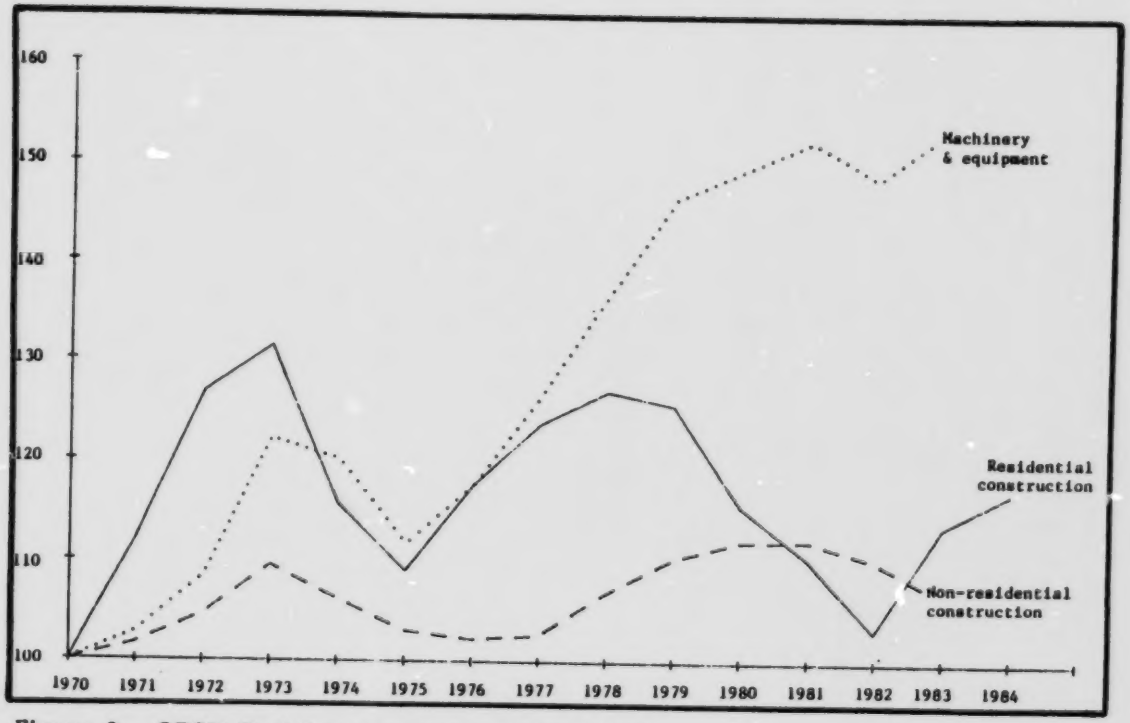

Figure 2. OECD Real Investment by Type of Asset (index numbers 1970=100)
Source: OECD Historical Statistics 1960-83

Over the 1960-83 period, nonresidential construction made up 36 percent and residential construction 25 percent of total OECD fixed investment.

Table 2 summarizes the slowdown in capital expenditure compared with total real GDP since the 1960s, and, for good measure, includes figures for industrial production and automobile output.

Table 2

OECD AREA GROWTH RATES 1960-83

	1960-68	1968-73	1973-79	1979-83
Gross domestic product	5.1	4.8	2.7	1.2
Industrial production	6.3	5.5	2.1	-0.4
Gross fixed capital formation	6.5	5.9	1.1	-0.3
of which:				
Residential construction	5.7	6.5	-0.8	-2.5
Nonresidential construction	6.5	3.9	0.1	-0.8
Machinery & equipment	7.3	7.6	3.0	1.2
Automobile Production	6.5	5.7	0.2	-1.0

Sources: OECD & IMF Statistics.

The addition of figures for 1984 would not materially alter the conclusions that can be drawn. A goodly part of the declining intensity of use of metals is closely related to the relatively poor performance of the sectors to which metals are sold. The question then arises as to whether these weak performances are irreversible. Logic, quite apart from the deteriorating state of the infrastructure on both sides of the Atlantic and Pacific, suggests that they are not. To some extent they are yet one more manifestation of the excess, or wrongly located, capacity engendered by a sudden and unpredicted change in the rate of economic growth, and by marked shifts in relative costs. The mineral industry's customers have been as affected by these factors as the industry itself.

Steps and Slopes

Strangely enough, its sectoral composition has not figured prominently in most explanations of recent trends in demand for metals. Instead, attention is concentrated on accelerated technological change; on the rapid spread of computer aided design in all its ramifications, and on the development of new materials and more precise manufacturing techniques. Intensity of use may have fallen in the past, runs the argument, but "you ain't seen nuttin yet" (to quote an ungrammatical utterance of the U.S. President). All is clearly not for the best in the best of all possible worlds, but is it really a Panglossian view of the future to suggest that such apocalyptic forecasts for the older metals are somewhat overdone? The burden of proof surely lies on those who make them, and they tend to forget that the effective diffusion of technical change is a much more protracted affair than the initial innovation. In short, substitution will lurch somewhat unpredictably, much as it has done in the past, rather than in leaps and bounds.

More ephemeral influences have also been at work on demand for metals in recent years. These are mainly linked with the re-emergence, albeit at historically high levels, of the norm of positive real interest rates in North America and the United Kingdom. Coupled with greatly reduced inflationary expectations, such rates have virtually eliminated speculative demands for metals, and have encouraged the liquidation of non-trade stocks. Consumer preferences have decisively switched from materials to financial assets. Genuine users have also pared their stocks to the bone, assisted in this regard by even more sophisticated computer-based techniques of inventory management. These reductions in inventories throughout the production and distribution chain are once-for-all steps. Now that they have occurred they should theoretically have no further influence on demand. That remains to be seen in practice. It is one thing to boast about just-in-time inventory policies when supplies are plentiful and prices weak, but quite another when there is no spare material available to keep the presses running even for ready money. Furthermore, an overall reduction of pipeline stocks reduces the timelags between changes in final demand and in requirements for raw materials, and increases the system's capacity for short-run surges in demand. The aluminium industry was caught by such a surge in 1983-84.

Excess Capacity

The inevitable counterpart of the slackened growth of demand for primary metal coinciding with long lead times for investment has been a general persistence of excess capacity. This was compounded by a general failure to recognize that the mining industry faced something more than a severe and prolonged cyclical downturn. The easiest route to cost cutting in order to sustain profitability in the late 1970s and very early 1980s was to expand, which further compounded the overall problems. The desires of raw material producing countries to upgrade their raw materials and of consuming countries to establish their own plants rather than rely on imports worsened the surplus at the processing stage. Figures 3 and 4 show the trends since 1972 in the amount of mine capacity in operation, and in its utilization for four base metals. Capacities, always fairly imprecise if only because of changing ore grades, have been calculated on a consistent basis throughout. Mines which remain shut for an entire year are not included in that year's capacity, and this gives an upward bias to the utilization rates in the later years. Figures 3 and 4 look at copper and nickel, and figures 5 and 6 at lead and zinc.

It should be remembered that 1972's utilization rates were depressed by a recession which may seem mild in retrospect, but which appeared fairly severe at the time. Each metal naturally has its own idiosyncracies. Nickel has occasionally been affected by lengthy strikes, and primary lead mines are partly governed by demand for silver and zinc and partly cushioned by varying production of secondary metal. Figures 3-6 demonstrate the persistence of excess capacity since the 1973-74 boom. This excess was worsened by increases in the capacity of all metals except primary lead. The relative stagnation of the latter helps explain the boom in lead prices during the late 1970s.

Lest these four base metals are regarded as special cases, table 3 looks at a much broader spread of 45 minerals. It contains approximate measures of the Western World's degree of capacity utilization in the mid 1980s. The figures are fairly rough and ready because they are based on 1984's mine production and the U.S. Bureau of Mines' projections of capacity in 1985. Not all the new mines included in the latter will have materialized, and some existing mines may have been closed. Furthermore, many of the mines included will seldom, if ever, produce at their maximum nominal throughputs. Even with these very important qualifications, the table does give a useful snapshot of the general extent of surplus capacity in the mining industry.

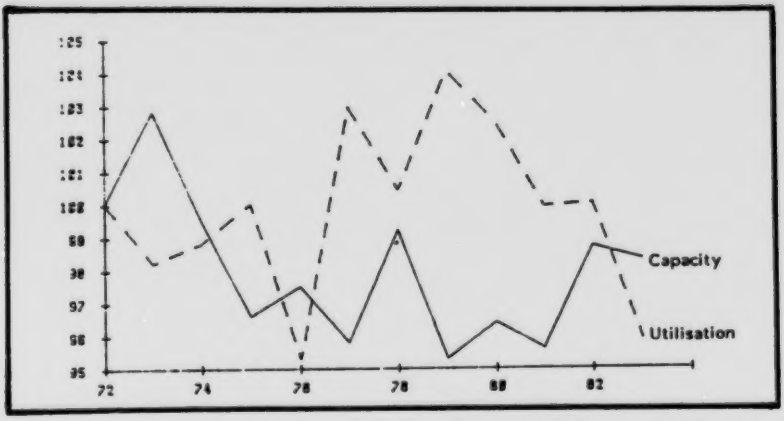

Figure 3. Mine Capacity and Utilization: Copper, 1972-83 (index numbers 1972=100)
Source: RTZ Mine Information Service

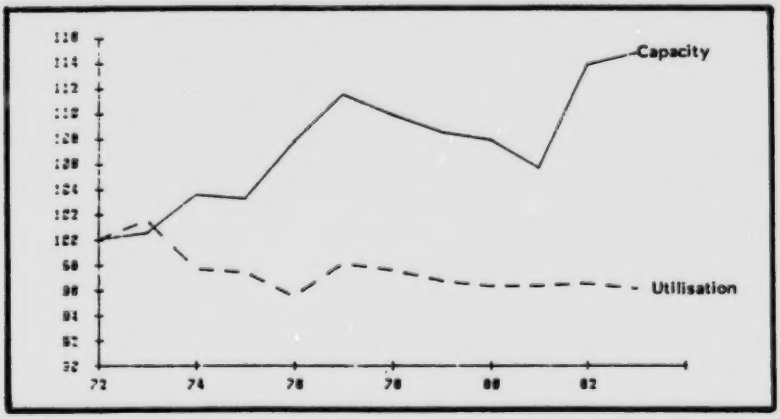

Figure 4. Mine Capacity and Utilization: Nickel, 1972-83 (index numbers 1972=100)
Source: RTZ Information Service

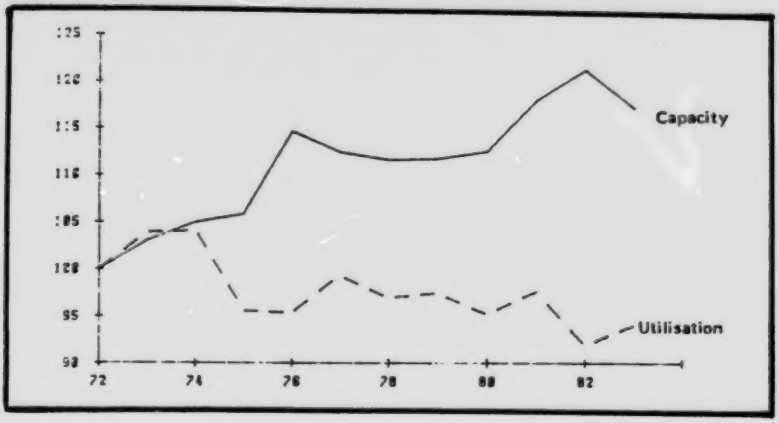

Figure 5. Mine Capacity and Utilization: Lead, 1972-83 (index numbers 1972=100)
Source: RTZ Mine Information Service

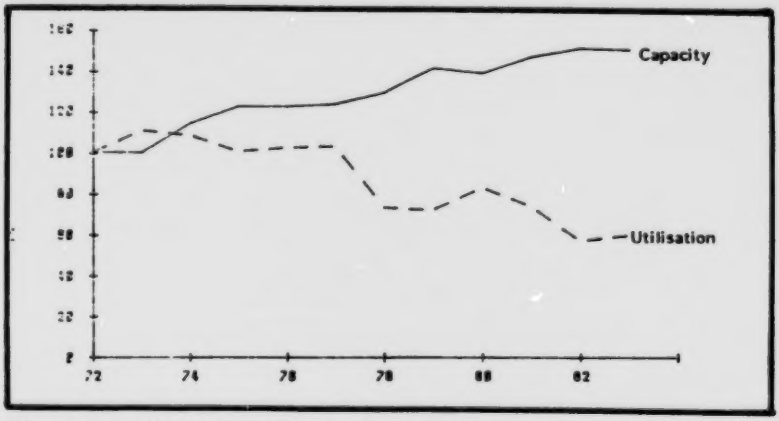

Figure 6. Mine Capacity and Utilization: Zinc, 1972-83 (index numbers 1972=100)
Source: RTZ Information Service

Table 3

WORLD CAPACITY UTILIZATION IN MINERALS: MID 1980s

Mineral	Capacity Utilization (percent)	Mineral	Capacity Utilization (percent)
Aluminium: bauxite	56	Mercury	44
alumina	64	Mica	47
metal	63	Molybdenum	57
Antimony	59	Nickel	58
Arsenic	43	Niobium	47
Asbestos	60	Phosphate	79
Barytes	70	Platinum Group	77
Beryllium	27	Potash	76
Bismuth	58	Salt	73
Borates	60	Silver	82
Bromine	76	Strontium	86
Cadmium	58	Sulphur	67
Chromium	69	Tantalum	61
Cobalt	69	Thallium	68
Copper	68	Tin	70
Fluorine	65	Titanium: ilmenite	62
Graphite	91	rutile	75
Gypsum	94	Tungsten	73
Iron Ore	54	Vanadium	46
Lead	72	Vermiculite	63
Lithium	57	Zinc	75
Magnesium	51	Zirconium	70
Manganese	66		

Sources: Capacity from Mineral Facts & Problems, 1980 Edition. USBM Circular 671.
Production from Mineral Commodity Summaries 1985. USBM.

Note: capacity utilization is shown as production in 1984 as % of estimated capacities in 1985. In most instances the percentages are based on mine output only.

Some Effects of Excess Capacity

Many of the mineral industries' present problems flow directly from the persistence of surplus productive capacity for so long. Whether or not that is a structural change is somewhat debatable, as it carries the seeds of its own elimination. In some minerals the restoration of supply and demand equilibrium is well advanced, whereas in others it started later and has much further to go.

The main effects of excess capacity have been twofold. First, the previous close link between prices and costs has been broken. This is best demonstrated by figure 7, which is by now probably fairly well known. It shows copper costs and prices annually since 1969.

Figure 7 compares average high and low LME copper prices with four points on the cumulative cost curve of copper mines for each year. The points are respectively 25 percent, 50 percent, 75 percent, and 90 percent along the curve of cumulative production. In previous years, when supply and demand were broadly balanced, prices tended to hover above the upper limit, which might loosely be defined as marginal costs, but in recent years they have dipped well down. The mining industry has responded with vigorous cost cutting programs, of both the "good", or permanent and of the "bad" or temporary variety. The mix between "good" and "bad" is an interesting question that will probably only be answered precisely with the passage of time. Either way, cost cutting has been insufficient to force the marginal costs of many minerals below prevailing market prices.

This is partly because of the second main effect of excess capacity: it has offered considerable scope for the expansion of spot and terminal markets of all forms. New entrants, and producers without forward linkages with customers, have resorted to traders and merchants to dispose of their output. These middlemen are more concerned with their margins than with the basic supply/demand balance. Also stocks have been amassed by producers, and merchants, some of whom may be constrained to sell by financial pressures. This rise in producers' stocks is a counterpart of the rundown of consumers' inventories already mentioned. Major producers have been unable to hold to cost-related list prices, and the consequences has been greater price volatility, and lower price levels relative to average costs.

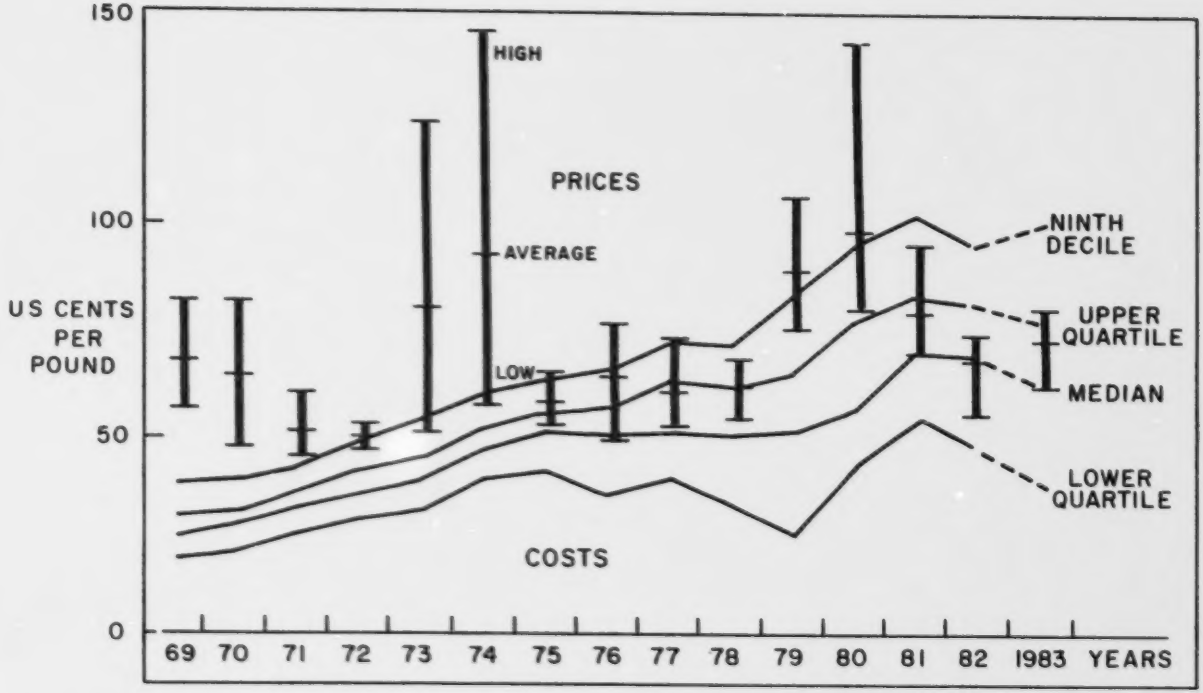

Figure 7. Cash Breakeven Costs and LME Prices of Copper, 1969-83 (U.S. cents per pound in money terms).

The Diffusion of Political and Economic Power

The weakened ability of major mineral producers to control their prices is one by-product of a genuine structural change over the past twenty years. This has been the diffusion of political and economic power away from North America and Western Europe. The rapid development of Japanese demand opened up sizeable new opportunities for Pacific Rim mineral producers in the 1960s and early 1970s, creating, for example, a market in copper concentrates. The more recent development of other South East Asian economies and of Latin America has further widened markets, incidentally increasing the scope for merchants.

More important, the decolonizations of the post war decades were followed by strong desires for economic independence to support political independence. Canadians do not need reminding that economic nationalism, particularly when concerned with resources, has not been confined to the developing countries. The wave of nationalizations of the late 1960s and early 1970s changed the mining industry's structure of ownership and weakened the hold of major international mining companies on world supply. Tax increases everywhere greatly lowered the mining companies' financial resilience in hard times. The successor companies, usually state owned or controlled, who have often made considerable contributions to additional capacity, have lacked marketing and financial expertise. Furthermore, they have perforce paid far more regard to national economic objectives than their predecessors. It is unclear whether the more recent temporary entry of the oil companies was, with apologies to Karl Marx, history repeating itself as tragedy or as farce. It probably depends on which side of the fence the spectator of that interesting episode in the mining industry's recent history was sitting. The oil companies have not been the only new entrants who have further spread the industry's ownership in recent years.

Much of the comment about the damaging effects of state ownership on the minerals industry has been marked by an almost complete absence of logical analysis. The main impact has been a diffusion of power and objectives on the producing side of the industry, and a further weakening of links between producers and the market.

Final Comments

The more usual complaint about state-controlled production is its inflexibility. That is merely one aspect of these

weakened links, and state-owned producers are by no means the only culprits. The conflict between the requirements of healthy mineral and metal markets on the one hand and the preservation of jobs and local incomes on the other is being fought throughout the world. All producing and consuming countries are in the long run best served by a healthy and efficient minerals industry whose worldwide supply and demand are in broad dynamic balance. Unfortunately, measures being taken in many countries, and not least in some Canadian provinces, are deferring the restoration of that balance. Where such measures are a response to genuinely temporary adverse factors, they may be justified. It is, however, better to act directly on the basic causes of imbalance, such as an over-valued currency, than on the symptoms, such as uncompetitive mines. Subsidies and temporary reductions in the prices of inputs merely transfer the mining sector's burdens to someone else. Herein lies the perennial dilemma of the mining industry; individual survival may be at the expense of prolonging the overall imbalance. Yet that imbalance is gradually being righted, and the survivors can look forward to a reasonably healthy old age.

CHANGING DEMAND PATTERNS:
Panel Discussion

William G. Deeks

Change is all around us. This is particularly so for the business of producing and selling metals and minerals for end-use markets. Historic change has always been viewed as cyclical change, and we are probably still in a cyclical pattern but the time frame from the beginning to the end of the cycle has been considerably extended. In addition to cyclical change, however, we are also seeing the effects of structural change. A definition for structural change is change taking place which is permanent and probably not reversible.

Examples of structural change include: competition from production in structured economies; the economic impact of changing currency values; the competitive thrust from new man-made materials; the impact of design changes, particularly for consumer durable products making the use of traditional materials obsolete, changing growth patterns in markets related to affluence and population growth; and changing consumer expenditure priorities. Collectively, all these changes are having a profound and negative impact on the economics of the mineral industry, especially in North America. Intensive competition has been created for markets, partly between producers in different economies with different currencies and partly between materials themselves.

Historic ideas of value are being challenged. What is the right price for a commodity today? Does it link to historical trends, or is it, in essence, facing a new set of realities in terms of value opposite substitute materials? Everywhere one looks, production costs have to be reduced in dollar-based economies in order to compete with lower wages and currency values from other countries. Are jobs in our society worth today what they were worth 10 years ago? What will happen to the level of wage rates in traditional U.S. and Canadian industrial centres compared to the willingness of people to work for much less in other countries and even the southern United States? Have some sectors of our industry been burdened with taxes and other costs related to working with government which are eroding their competitive ability? Are there environmental burdens placed on the production of metals and minerals in Canada and the United States which cannot be borne and, there-

fore, are the forerunner of a noncompetitive and closed down industry? These are all questions we have to focus on now.

Searching for answers is frustrating, as there do not seem to be many readily available ones. Obviously, one of the answers to the problems being faced by the mining and metallurgical industry is to put a great deal more effort into product research and market development. Along with this needed commitment, there is also the need for continuing effort in improving production systems in a push for much higher productivity and, finally, real emphasis on the need for impeccable product quality.

As well, new initiatives in the visibility and transparency of the industry are required. Noranda has been a strong advocate of the merits of study groups on an international basis to provide a forum where the problems and opportunities for a particular commodity can be reviewed by the major participants and their governments in the hope that more sensible business decisions will result. This should lead to an enhanced industry with a deep commitment for product research and market development, rather than a depressed industry with no funds to protect itself.

Overall, our belief is that, as never before, the industry must become market driven. By market driven, one means an industry that is concentrating on customers and what customers expect from it.

The GM Saturn program is a really good example of a major change taking place in the manufacture of a world-class competitive small sized automobile in the USA. Saturn will be seeking to cut the cost of making cars in North America in half, and will be striving to accomplish this through a high degree of automation, rigid inventory control, new assembly and component manufacturing systems, faultless performance of parts at all times, efficient use of materials, elimination of scrap, and employment of the kanban concept.

Kanban originates in Japan and is the practice of a Japanese housewife to indicate to her baker that she needs another loaf of bread by putting a small wooden disc in a wicker basket outside her door. This truly is "just-in-time delivery" of a needed product to do a specific job. The housewife's inventory control procedure is through the use of the wooden disc which triggers the delivery to provide the bread she needs to feed her family at that moment. Industrially, the kanban concept embodies statistical process control to assure a quality driven production system and just-in-time delivery to ensure direct shipment of components onto an assembly system without the need to hold wasteful inventories and all the double handling that goes with it.

Saturn and kanban are simply a reflection of the way things are heading, and if they are heading that way in the motor vehicle industry, eventually all manufacturing operations will be faced with the same need for productivity gains, modernization of processing facilities, better manufacturing assembly systems, computer controlled and organized flow of materials and very much higher-quality standards.

These concepts present some formidable challenges for Canadians. For many of our metal and mineral businesses, the Canadian market is too small to justify the kind of investment needed to provide the state-of-the-art facilities necessary to be competitive. The answer for Canada has to lie in much greater access to the U.S. market. It is only with that access that large segments of the Canadian manufacturing industry are going to be able to justify the capital needed to improve their facilities in order to be competitive.

The irony is that we really have no choice, because if we do not modernize and become competitive, Canadian manufacturers will slowly go out of business as their products are replaced with products made elsewhere, quite possibly in the Pacific. Already there are small manufacturing enterprises in Ontario shifting their production to the Pacific and using their Canadian operation as an assembler and distributor. It is time we focused on what is happening to these basic core manufacturing enterprises in the Canadian economy. We cannot afford to have our basic production systems move offshore. We cannot survive as a service country without the wealth creation that goes with an active and expanding mining and metallurgical industry on the one hand and a manufacturing and processing industry on the other.

Part of the hurdle we have to cross in facing the competitive reality of the future is the use of computers in the management of our business. Modern state-of-the-art manufacturing and assembly processes are heavily linked to computer systems. Computers monitor the performance of equipment, providing exactly the right characteristics to produce a predictable high-quality part. Other computer-driven machines finish and prepare parts for final assembly. Even more sophisticated machines have the ability to sight, through laser technology, the different configurations coming down an assembly line and then to program the action at each station automatically, exactly conforming to the particular component approaching.

The guesswork is being taken out of the production process. Manufacture proceeds on the basis of known data

and predictable machine action. No longer is it feasible for one man to operate one machine. Now it is more likely that one man will operate ten machines, and work from a computer console.

The hurdle of moving into electronic management is both a knowledge and a culture shock, and it cannot be done by chance or happenstance. Introduction of electronic management systems into an enterprise must be carefully planned, with good orientation and training programs for the people involved. It is absolutely essential that it have support from owners and senior managers in order that the people involved realize the fundamental commitment of the enterprise to change which is necessary. A major focus on manufacturing in Canada with this perspective is required today.

To summarize, there is no question that we are being buffeted by the forces of change today. Answers to our problems lie in increased and serious commitment to research and development at both the processing and the marketing stages of our industry. Access to the U.S. market is vital to expand our market base in order to justify the capital needed to upgrade our facilities. Competition is severe and will continue to be so, in many cases arising in structured economies with premium domestic markets protected from imports and juicy incentives for exports. It is absolutely necessary that Canadians understand the competitive trade environment in which we are competing, so that appropriate actions can be taken in Canada to counter the destructive impact of such subsidized activity.

CHANGING DEMAND PATTERNS:
Panel discussion

George A. Jewett

The essence of structural change today is that competition is forcing industry to achieve major improvements in productivity, product quality, and performance. Industrial society experiences change of this magnitude only when technology offers the possibility of significant increases in efficiency, such as those offered by steam power and Henry Ford's production lines. Materials technology is the moving force this time. The momentum of such structural change is a flood tide, which benefits us all, if we can learn to swim.

This time, major technological developments in biology, information processing, and production technology are happening concurrently. All will have dramatic effects on society, for the better. Materials technology is almost certainly the most significant science of our age. In its own right, it makes cheaper, more reliable and higher performance possible. In addition, new materials developed by materials scientists make the advances of the other technologies possible.

Remember - the only reason Leonardo da Vinci designs did not "fly" was lack of appropriate materials. Science is now able to respond with materials to meet the needs of any innovator today. New competitors with new rules are attacking metal markets with innovative products developed in their research labs.

A common objective in industry today is higher quality, but at the same price. To compete, suppliers must improve quality and meet the market's demands or else they will witness diminishing sales. Quality can be improved either by increasing specifications, or by achieving more consistent performance by narrowing tolerances. There is another way: by ensuring that the user is taking full advantage of the properties of metals in his design and manufacturing.

Most manufacturing in metal in North America is based on outdated technology and substandard quality control, and as a consequence, overdesign is common. The result is loss of competitive advantage. The copper radiator is a case of a market that need not have been lost, because a competitor introduced new manufacturing technology, and better quality control. If the copper industry had been

there first (and it could have been) a 50,000-ton market could have been preserved. Of course such activity goes beyond the industry's traditional view of "selling".

The Oxford English Dictionary defines the verb to sell as follows:

- to dispose of in exchange for money;
- to keep stock of for sale;
- to be a dealer in;
- to prostitute for money or other consideration;
- to make a matter of corrupt bargaining;
- to find purchasers.

The plastics industry uses the last concept; the metal industry, the first three, although there are some who suggest that numbers four and five have been widely practiced in the metal trade in recent years. Polymers have achieved their greatest market penetration in replacing metals, and this trend is projected to continue for at least ten years. The loss in metal markets could exceed one million tons in aggregate over this period.

Polmer producers have expanded their markets by first analyzing the market opportunities carefully and correctly. They did this ten years ago. They then produced products to meet specific market requirements. Next, they developed efficient and cost-effective production processes for the user, and gave them to him. Engineering plastics commonly replace metals on a one-to-one basis, by volume, and commonly achieve weight savings of 50 percent - often because of overdesign in metals, and inefficient manufacturing metal technology.

The success of engineering polymers in replacing metals can be attributed to a variety of factors. Among the most important are cost savings and weight savings. While the raw material cost of even the most inexpensive engineering polymers exceeds that of metals, the plastic materials offer economies in processing and fabrication. Engineering polymers may be injection molded with significantly lower energy consumption and at faster production rates than die casting, the similar processing technique for metals. Many plastic moldings require no post-mold finishing, while metal castings and stampings must often be polished, deburred and cleaned.

Engineering polymers are particularly adaptable to production of multifunctional, single-piece assemblies. For example, an injection-molded business-machine housing generally includes such features as mounting bosses, through holes, integral color, and functional indentations,

which are incorporated during the molding cycle. With sheet steel housings, the cabinet must be formed and painted, fasteners attached and through holes cut or punched in separate operations.

Over the last 10 years, the plastics industry has organized effectively to create markets for their products, in spite of inferior specifications and market resistance. If the metals industry is to maintain market share it must do the same; it must learn to "sell" its product against plastics and other competing materials. The metals industry must focus on the marketplace, must be positive and look forward instead of backwards (which is what we do when we look at traditional demand patterns). The industry must learn again how to create demand.

Post World War II was an exceptional period in history, a period of exceptional demand when, in the words of Peters and Waterman, "anyone could make money". No one likes to be diminished in quite that way, but what if it is true? What if the period can be shown to be an historical aberration, and that there have been only two other comparable periods of inflation, escalating demand, and general increase in expectations in all commodity markets, especially metals? If that is true then we can anticipate years of stable commodity prices - in a very competitive market.

A CRS seminar earlier this year concluded that "metal markets are extremely cyclical". Let us get the tense right - they "were" but are not now, and almost certainly will not be in the future. We can identify oversupply scenarios in virtually every metal forward for at least ten years. In addition there is a new factor in the equation - substitution. Substitution is an ever-present threat today with stable, depressed prices. If the price of any metal should escalate rapidly today, the market will switch to alternative materials within a matter of months, or weeks. In most cases the switch will be irreversible for many years, if ever. For this reason there will be a powerful counterpoise to demand pull in this marketplace for metals, which will tend to keep prices stable for many years. Consequently, we can look forward to fluctuating demand, perhaps, but stable prices.

This is not all bad - it certainly clears the mind and may even provide the basis for some sound long term strategic selling strategies within the metals industry.

CHANGING DEMAND PATTERNS:
Panel Discussion

Gordon R. Peeling and Winston Chambers

Change breeds apprehension. Apprehension affects expectations, and expectations influence the behaviour of industry, labour and government. Thus, any change which is perceived as a threat to the established economic, social and/or political order is usually destabilizing and, in consequence, costly.

Structural change, i.e. fundamental shifts in the relative importance of the principal sectors of the economy, is of that kind. It is a source of serious concern because of its possible adverse consequences. It could, and indeed it has, resulted in:

- heavy financial losses and even the demise of companies;
- considerable unemployment through the obsolescence of skills or through dramatic changes in the capital-labour ratios of new production systems.

But structural change is not all bad. Despite its adverse effects, it it necessary for economic growth and development, and as a growth factor it invariably affords opportunities. In a sense, structural change represents a kind of paradox. On the one hand, it creates many difficult economic problems; on the other hand, it offers novel opportunities for industrial development and expansion. In this paradox lies the formidable challenge of how best to exploit the opportunities afforded by structural change while minimizing the private and social costs of warranted structural adjustments.

This is the critical problem which industry, labour and government must address. It is not an easy problem. It cannot be resolved overnight, and the way in which it is resolved will be crucial for the future commercial viability of the industry as well as the industry's contribution to the Canadian economy. Thus the development of appropriate structural adjustment policies becomes all important. But what, one may ask, are appropriate adjustment policies?

This is a singularly important question for which there can be no absolute answer. This is so because the answer entails normative considerations: i.e. subjective consider-

ations of what ought to be. Not surprisingly, therefore, there are likely to be widely different perceptions of what, in a given situation, constitutes appropriate adjustment policies. None the less, the formulation of structural adjustment policies, however perceived, demands a good understanding of:

- the determinants or sources of the structural transformation we are now experiencing;
- the magnitude, extent and impact of the changes;
- the nature of the threats they pose;
- the opportunities they present;
- the options that are open to the mineral industry; options which must be considered with reference to certain constraints. Some of these constraints are the openness of the mineral sector, the market structure of the industry, (e.g. absence of monopoly power) and the mineral development and trade policies of competitors and trading partners.

Determinants or Sources of Change

Broadly speaking, structural change is the consequence of the interaction of a complex set of factors. It may be brought about by underlying trends in productivity, technological innovation, demand patterns, or trade flows.

Structural change in the mineral industry can be attributed mainly to four factors. These factors are:

- economic forces;
- scientific and technological imperatives;
- government policies and regulations;
- international institutional activities and arrangements (e.g. concessionary financing of mine development by international financial institutions).

These four factors - economic, scientific and technological, government, and international institutions - are not mutually exclusive. Their activities interact to effect far-reaching changes in both patterns of supply and demand for minerals.

Economic Forces

The increase in energy costs, occasioned by a series of oil price shocks and the attendant energy conservation drive,

greatly affected the volume and composition of mineral consumption, as well as the processing technology of energy intensive minerals.

The imperative of reducing energy consumption, or rather of reducing energy costs in industrial production, prompted design changes in the automobile, aerospace and other major fuel-consuming industries. Design changes emphasized weight reduction and improved energy efficiencies. This led to substitution among metals. It also increased the demand for plastics, composites and modern ceramics as replacements for metals in several design applications.

In a period of escalating energy costs, the use of a new class of plastic-based materials - called the composites - has much to commend it. Composites can be stronger then steel, lighter than aluminum, and more rigid than titanium. Graphite/epoxy composite has the same strength and rigidity of aluminum, but is about 40 percent lighter. These properties of the composite are clearly economically and technically desirable in designing for performance and fuel efficiency. This explains why major commercial jetliners like the Boeing 767 and 757, Douglas DC-10s, and Lockheed L1011s all use carbon/graphite composites in several secondary structures to eliminate upwards of 1200 pounds of structural weight.

Aside from energy costs, the necessity of having to remain highly cost-competitive has been a source of structural change. In periods of low economic growth rates, stagflation, or major cyclical contractions in economic activity, new technology may be introduced to reduce the unit cost of production. The introduction of robotics in mining, and the emergence of mini-steel mills are cases in point. They represent significant structural changes on the supply side.

Scientific and Technological Imperatives

Certain scientific advances and technological developments create a demand for new materials. These new materials are critical requirements for the development and operation of the new technology. This kind of material requirement is evidenced in aerospace, rocketry, information-communication networks, and in the use of lasers.

The aerospace industry's need for materials with high strength-to-weight ratios and improved thermal shock, dielectric, abrasive, and refractory properties initiated a considerable amount of research and development in cera-

mics during the last decade. Among the advanced ceramic materials which was produced during this period was silicon carbide. One of the hardest substances known to man, it is used extensively in the manufacture of rocket nozzles. Currently, it is also being used for critical-wear components for pumps, valves, compressors and other equipment used in energy and chemical process industries to control flows of gases, liquids and slurries.

This use as a critical-wear component makes silicon carbide a substitute for some metals. Similarly, new concepts in communications, such as the use of satellites, microwaves, and optical fibre, have threatened to displace copper in communications.

Government Policies

Government, through various policy initiatives, contributes to structural change. Defence, environmental protection, resource procurement, and trade and development policies all can, and do at times, induce structural change.

Much of the development in materials technology in the U.S. is defence related. Graphite epoxy composites are now extensively used in fighter aircraft; and a major development in the use of composites in helicopter airframes is now under way. The U.S. Army sponsors the Advanced Composite Airframe Program (ACAP) which is attempting to produce the technology needed for designing and manufacturing new helicopters with all-composite airframes.

NASA is another strong supporter of composites, as is evidenced by the use of 4000 pounds of the material on the shuttle orbiters. The 60-by-15-foot bay doors of the Columbia are made entirely of graphite composite, making the craft 2700 pounds lighter than if it were composed entirely of aluminum structures.

Governments, through their regulatory initiatives, can also restrict the use of certain materials for a variety of reasons. The impact of environmental pollution and health protection regulations on the use of lead and asbestos is now well known.

The resource procurement strategies of resource deficient industrialized economies can also effect structural changes on the supply side. Where resource deficient economies endeavour to diversify their sources of supply both to minimize supply disruptions and to improve their bargaining leverage, such policies sometimes lead to major supply/demand imbalances demanding structural adjustment on the supply side. Indeed, a major problem facing many

mineral commodities today is the existence of surplus production capacity.

These examples of structural change are disturbing. For some observers, they portend a sunset industry. For others, they present difficult problems and challenging opportunities. How damaging has structural change been for the industry? How much of a threat does it pose for the future commercial viability of the industry as a whole, or major segments thereof?

These are, for the most part, empirical questions. To answer them adequately we must resort to facts and figures. There is, however, a paucity of relevant data. The reasons for this lack of data are two-fold. Firstly, the structural transformation is still in progress. Secondly, the industry is still being adversely affected by the lagged impact of the last global economic recession.

Nature and Extent of Structural Change

The fact that the industry has been affected simultaneously by a structural transformation and a major cyclical contraction compounds the difficulty of specifying the magnitude of the impact of structural change per se upon the industry.

Notwithstanding all this, there is some telling evidence of structural change. The lead industry provides a good example. Historically, lead has two major end-uses. The first of these was the lead-acid battery, which accounted for over 60 percent of total annual lead consumption. The second important end-use was as an additive to gasoline. Automobile emission control requirements and the development of new battery systems have seriously eroded the rate of growth of lead consumption. To counter the declining demand for lead in traditional uses, lead chemicals have been developed for stabilizing asphalt against cracking. Roadways paved with this new asphalt are being tested in the USA.

This is all very interesting. But a knowledge of changing patterns of production and consumption of a commodity or set of commodities does not in itself provide a sound basis for examining the nature, extent and impact of structural change. To know where the industry as a whole stands, how it is adjusting, and how it should be adjusting to change, it is useful to examine structural change with reference to two things:

- intrasectoral shifts, or endogenous changes;
- intersectoral shifts, or exogenous changes.

Although these two categories of structural change are not mutually exclusive, their identification is analytically highly desirable.

It is not fully realized, for instance, that there are major intrasectoral shifts from metallic minerals to non-metallic mineral materials. Examples of this are found in the substitution of composites for aluminum, titanium and steel; ceramic magnets and electrical conductors for conventional alloys; and optical fibres for copper. A tremendous amount of research and development has been under way during the last decade in the field of ceramics. Ceramic materials, which include ceramic fuel elements, piezoelectric materials, glass ceramics, magnetic ceramics, nonlinear dielectric ceramics, cermets, dry-film lubricants, special glasses, ceramic composites and refractory ceramics, are all derivatives of industrial minerals.

Ceramic development is reaching realistic commercial stages, particularly in Japan which is leading the way. They have established government-coordinated industrial initiatives involving over 200 private companies to work toward such long-term objectives as the development of fully ceramic engines. These programs also contain many shorter-term objectives to produce such ceramic products as auto parts, knives, scissors, etc. These shorter-term objectives keep the R&D relevant to consumer needs. They also provide revenue from sales to pay for R&D, while creating consumer awareness of the actual and potential use of ceramics.

The Japanese approach differs markedly from those of the USA and U.K., which are largely defence driven. The advantages of low friction, high wear resistance, and high temperature resistance make ceramics a desirable material for high temperature engines, such as fighter aircraft and tanks.

Challenges & Response

How have these forces for change affected the demand for and supply of minerals and metals generally? What problems do they pose, and what's involved in responding appropriately?

Broadly speaking, structural change and an accompanying cyclical economic contraction have led to a marked decline in the rates of growth of mineral production and mineral consumption. This reduction in the rate of growth of mineral consumption has given rise to excess supply, under-utilized production capacity, intense competition for markets, depressed mineral commodity prices, shrunken

profit margins, capital losses and resurgence of protectionism.

These phenomena have posed and continue to pose a major challenge to the Canadian mineral industry. Simply stated, the challenge is how to gain access to and maintain an optimum share of emerging markets for minerals and mineral markets.

In addressing the topic "Response to Structural Change", the 1985 Mineral Outlook Conference advanced some policy presciptions. The Conference held that if the Canadian mineral industry is to effect appropriate structural adjustments then the industry should strive to:

- reduce the cost of production by improving technology and productivity;
- eliminate waste, emphasize quality, and develop measures that focus on long-range goals rather than short-term return on investment measures;
- listen to the market;
- support and direct product development and market-oriented applied research;
- continue exploring new ore bodies;
- develop commodity study groups to improve market transparency.

These are necessary conditions that must be met to be competitive, but they tell us nothing about the market itself.

An essential precondition for gaining market access and maintaining an optimum market share under changing conditions is to identify the market or markets in which we must compete. This requires us to ascertain:

- how the industrial structures of our major trading partners have changed and are still changing;
- how these changes have altered and are still altering traditional patterns of mineral materials demand. (This is, no doubt, what is involved in the expression "listening to the market".)

Once the emerging material requirements of our major trading partners are identified, then the structure of our mineral industry should be examined, to determine what changes, if any, are expedient if the industry is to respond profitably to the changing material requirements of a world economy in transition. This could be a rewarding exercise. It would indicate desirable structural developments; it would provide a framework for evaluating the efficacy of traditional mineral commodity arrangements; and it could influence intra-sectoral investment flows.

FUTURE SUPPLIES OF METALS: THE TRANSITION

Simon Hunt and Graham Haclin

Economic Cycles to the 1990s

Seeing so much turmoil in so many producing countries that are substantial suppliers of metals, we were tempted to entitle this paper "The Renaissance of Mining in Developed Countries". But in discussing the concept, we decided that, while it is possible to reach that conclusion, it is premature. Premature partly because such a reversal in the pattern of world mineral supplies would require, among other things, the full recognition of the cyclical nature of the mining industry by the host government, such as Canada, in devising a tax structure which recognized this fundamental of mining. But more of that later.

Today I would like to leave two main thoughts with you. Firstly, that the metals industry is in a transition period, adjusting from endemic surplus to healthy growth and profitability. Adjustments, however, whether structural or evolutionary, present challenges and opportunities; and mining is no exception.

Secondly, the mining industry needs to protect, nurture and develop its end use markets as a matter of urgent priority. Failure to do so, or to do so using the cabbage patch philosophy without regard to the overall benefit to the industry, will prevent this transition from being accomplished. Mines need markets just as markets need mines.

Mining is a microcosm of the world at large. When long-term capital investment falls, as in the last decade, intensity of use for many metals declines; and vice versa. Looking at future supplies in isolation is as much good as looking at a bull elephant at ten yards through a pair of binoculars: the result would reproduce only the painful experience of the last decade. Demand and supply are interdependent. So before discussing with you the patterns of supply, which we see developing, I would like to share with you briefly our views of the economic cycles which we see shaping the world to the mid 1990s. I do so not only because what happens at the macro-economic level will directly affect demand, but because these cycles will affect supplies and management philosophy towards investment or, indeed, disinvestment. Recent experience is nearly always a powerful influence on the formulation of corporate policy.

We expect that the next ten years will see three recovery periods and two recessions. The striking feature of the recovery in the United States so far has been the growing mountain of debt at all levels, mirrored by the explosion of credit. For instance, for 1984 as a whole, nominal gross national product in the USA grew by $360 billion, but total domestic indebtedness increased by $715 billion. Thus each dollar added to GNP required two dollars of additional debt, a ratio which soared to 3:1 in the fourth quarter.

The distinguishing characteristic of the U.S. recovery is that debt is outpacing everything else: GNP, money supply and income. To find anything comparable in peace time, we must go back to 1929 when the debt-to-GNP ratio was a little over 2:1.

Such an excessive increase in money and credit should create inflationary pressures. Yet on the surface, none is apparent, as supported by the evidence of the GNP deflator, oil and commodity prices. Yet beneath these broad aggregate numbers there are some disturbing signals. In effect, inflation is being pulled upwards by the credit expansion in those sectors of the economy that are sheltered from imports, such as government purchases of defence and nondefence goods, the services sector, and residential fixed investments. Conversely, inflation is being pulled down by the dollar's strength, with import penetration preventing U.S. manufacturers from raising prices.

But the important point is that:

> borrowing creates an inflationary excess of purchasing power whenever the lender believes that he has not lost control of the purchasing power he has lent out until the borrower pays him back, but can sell or pledge the borrower's note whenever he wants to do a little more spending himself,

as Ashley Bladen wrote recently.

Looking solely at price indices as an indicator of inflation in the USA may well be misleading, as Keynes admitted after the hyper-inflation in Germany:

> Anyone who looked only at the index of prices would see no reason to suspect any material degree of inflation; whilst anyone who looked only at the total volume of bank credit and the prices of common stocks would have been convinced of the presence of an inflation actual or

impending. For my part I took the view at the time that there was no inflation. Looking back, I believe that a genuine inflation developed some time between the end of 1927 and the summer of 1929.

Today the Federal Reserve is in a box that is tightening continuously. Policy formulation has to be directed towards maintaining, or at least trying to maintain, economic growth and preventing the insolvency of a number of institutions. At the same time the Federal Reserve does not want to reignite inflationary fears. Yet it is unable to lean against these fears aggressively because an increase in the cost of money would have dire consequences on the attitude of Third World debtors. Indeed there are ominious signs that a deterioration will occur in the coming months as these debtor nations are finding the social strains of continued austerity to be unacceptable.

It is against this background that we path our pattern of economic development to the mid 1990s. Timing is given as a guide to direction only, and not as a "given". If it were so, I would have no need to be here today!

Recovery Phase I. This will continue until June/July 1986 in the USA and end 1986 elsewhere. Late this year and in early 1986 economic growth will be surprisingly strong in the USA. Shoring up the Farm Credit System will require a large dose of fiscal and monetary stimulus, starting sometime in October. By year end a rising budget deficit and open monetization by the Federal Reserve will be evident. The dollar will fall, having first continued its recovery; base and precious metal prices will rise; and market perceptions and asset structuring will shift from a disinflationary environment towards inflation hedging.

In the second quarter of 1986 the Federal Reserve will be forced to lean heavily against these pressures. Base and precious metal prices should peak in Autumn 1986.

Recession I starts in the USA in August/September 1986 and the rest of Western World between December 1986 and March 1987. This recession may not be so severe as we earlier thought; the more prolonged recovery, higher inflation in 1986, and more patch work on LDC debt could further postpone the inevitable financial debacle.

Precious and base metal prices should reach their low point in July/August 1987.

Recovery 2 starts in the USA around October/November 1987 and elsewhere by spring 1988. This period is likely to be characterized by more severe inflation, by strong economic growth with base and precious metal prices

peaking in first quarter 1990 at levels beyond what we can contemplate today. For instance, one of my technical friends, who has been following these markets for as long as I am old, has a clear pattern of gold prices; each peak is six times the previous cycle's low price. Thus he maintains that $285/oz was the low to give a gold price in the first quarter of 1990 of $1710/oz! It is around this period that the financial system could come under its greatest strain.

Recession 2 starts soon after in Spring 1990, is deep, severe with a basic reform of the international monetary system a likely prospect. As a result, interest rates will plummet, inflation will be contained, and long-term borrowing costs will revert to the long-run average of around 2 percent in real terms.

Recovery 3 will start towards the end of 1991, resulting in durable growth characterized by capital investment, particularly in infrastructure, electrical generating and distributing capacity, and energy, reminiscent of the 1960s.

Such is a thumbnail sketch of what we see ahead. Against this background, I now turn to the changing supply and cost patterns of the industry, and to tax reforms, which are necessary in many developed countries.

Highlights of Host-Country Influences

Although as yet uncertain, there is evidence to suggest that during the next decade we may see a renaissance of the mining industry in the industrial world. Much will depend on the attitude of host governments, as I have suggested earlier, and will discuss later.

How can we suggest that mining in the industrial countries is undergoing recovery when all the evidence, for the past decade, suggests that the reverse is true? In developing countries, continued and more rapid devaluations, creating increased social tensions, rising inflation, shortages of capital and foreign exchange combined with declining ore reserves in a number of countries could bring this about. So let us look at a few countries briefly.

Zambia. Production decline is accelerating. The percentage of foreign exchange revenue now being returned to the mining industry has fallen to 19 percent, compared with ZCCM's stated minimum requirement of 42 percent. State mining tax, effectively a front-end royalty on production, has been doubled recently from 10 percent to 20 percent, putting a further squeeze on the hard-pressed copper industry. Morale at all levels is low. By the mid-1990s capacity will be below 400,000 tonnes.

Zaire. While Zaire has not recently been in the news, nevertheless the situation will always remain uncertain. Any disruption of its rail system to the South African port of East London would be disasterous because of the deterioration in the "national route" to Matadi.

Philippines. Despite the reactivation of Sipalay, based on Japanese finance, 9 mines remain closed in the Philippines, all having ceased production since 1981, representing a loss in copper capacity of some 45,000 t/a. Furthermore the two major producers, Atlas and Philex, are in trouble due to serious maintenance and operating problems brought about by the adoption of short-term expendiency measures, inadequate planning, insufficient investment and serious foreign exchange shortages. Couple this with the increasing political tension in the country, the future of the Filipino mining industry must now be questioned. Capacity will fall below 200,000 tonnes by the mid 1990s.

Peru. The well publicized political and financial problems of the country will make it difficult for the government or the mining industry to attract capital. Capacity is likely to remain at around current levels of 370,000 tonnes.

South Africa. The current difficulties facing the country include political problems arising from polarization of power and a government whose policies are not condoned by the outside world, as well as a large build-up of short-term debts.

Chile. The example of South Africa should not go unheeded for Chile. While copper production is never likely to be disrupted for long, political difficulties could surface over the next ten years, making investment there even more difficult. Nonetheless, unique projects, such as Escondida, will always eventually attract investment, probably with greater assistance from the international financial institutions.

The foregoing examples illustrate a fundamental change in the future supply pattern for certain metals. The timing element plus a combination of other factors point to future capacity limitations and a marked improvement in the balance between mine capacity and likely demand. By the early 1990s, and for intermittent periods before then, there is growing evidence to suggest that mine capacity utilization will be at a high level for some metals even assuming only modest growths in consumption. This appears to be true for copper and zinc, and, because of the decline in South African output, also gold.

The factors contributing to this change are:

i closures that have already taken place, coupled with the difficulties of reactivation with only modest gains in metal prices;

ii the over mining and high grading which have been forced on the industry due to weak metal prices, which will result in future grade declines, lower output and shortened economic lives for major mines;

iii the maturity of many mines, reflected in limited finite reserves, limited scope for incremental expansions, rising cost structure, and falling production;

iv price constraints, capital constraints, greater selectivity and a generally more conservative approach have led to delays and deferments of many new projects. The result has been a period when few new projects are coming on stream. This situation will continue for a further few years, and is in sharp contrast to the rapid expansion in capacity which took place in the 1960s and early 1970s which produced the severe supply-demand imbalance that has plagued the industry for almost a decade.

Let us examine, in a little more detail, some of the changes which are currently taking place and which will have a significant impact in the 1990s. In particular let us look at reserves, the maturity of many major mines, and mine closures.

Declining Ore Reserves

Paradoxically, while total world reserves of known mineral deposits have been rising rapidly, total world reserves of ore have declined. We must all remember that "ore" is an economic concept. Put simplistically, it is "mineral which can be mined and processed profitably". Thus, ore reserves are as much dependent on future metal price projections, capital investment, interest rates etc., as they are on the undoubted skills of the exploration geologist.

In the past five years, we have witnessed a rapid decline in the ore reserve base of many existing producers. This is attributed to the following reasons.

The Necessity to "High Grade" or "Over Mine"

This has been a legitimate and natural response to lower metal prices necessitating survival economics, namely "mining for cash". Nevertheless, a price has to be paid, either in the form of sharply reduced mine life, or the need for substantial capital injection. Typically, higher grade ores have been mined, thus appreciably lowering the remaining ore reserve grade, while long-term development has been kept to a minimum. The combination of sharply lower future grade trends and the need for substantial capital investment will inevitably jeopardize the future viability of the operation, in the absence of a substantial and sustained metal price improvement.

The Necessity to Reappraise Mining Schedules and to Raise Cut-Off Grades and/or to Reduce Stripping Ratios

Clearly, as economics change, mining operators have to reappraise their situation. Often this is a slow process. Mine closures can be categorized into two groups: first, those in which "ore reserves are depleted" and, secondly, those which have closed "due to low metal prices". Clearly, in both cases ore reserves by definition have been depleted. It has been suggested that reactivations of closed properties will inhibit metal price improvements. Although potential reactivations could have a modifying influence on metal prices in general, these mines need appreciably higher metal prices to justify the heavy capital investment necessary to bring them back on stream.

Maturing Mines

Mines, like humans, experience three phases during their life cycles; youth, middle age and maturity (not, I would add, to be confused with old age, which none of us experience!).

The youthful phase is characterized by expanding ore reserves and expanding production. A series of incremental expansions typically takes place, but the ore reserve base also increases despite rising output. In the middle phase, it becomes increasingly difficult to expand the ore reserve base. Furthermore, incremental expansion becomes necessary.

Nevertheless, most mining companies now accept that the future health of the metals industry depends on compet-

itive prices to ensure market growth. This lower price scenario must inevitably affect ore reserve calculations, leading to higher cut-off grades, lower stripping ratios, and modified mining schedules. We have recently witnessed a significant downward readjustment of ore reserves by many mining companies.

Mine Closure and Possible Reactivation

While uneconomic mines are not, by definition, mining ore, it is common to continue to refer to their mineral reserves as "ore reserves". However, once these operations have ceased production, it is reasonable to question whether the operation will be reactivated and consequently whether or not the mineral deposit should retain the status of an ore-body simply to compensate for declining ore grades. Finally, the mature mine is characterized by limited life, declining ore grades, and a whole list of adverse cost factors: e.g. deeper mining, extended haul distances, ventilation and pumping problems, temperature gradients, greater rock hardness and so on. In addition to cost pressures, declining ore reserves limit the scope for incremental expansion, thereby removing one means by which costs can be contained.

In both copper and zinc, the past five years have witnessed an unprecedented level of mine closures, particularly in North America. Taking copper as the example, some 920,000 tonnes of copper mine production has been closed in the past five years, based on production figures for 1980-81, as shown in table 1.

Table 1

COPPER

Country	Lost Production Capacity (t Cu in conc.)
USA	637,300
Canada	103,600
Philippines	39,000
Australia	25,000
Other	115,200
Total	920,600

As already outlined, high grading, over mining, limited stripping, reducing capital expenditure are all contributing to reduced mine life. Many of the world's major mines, developed in the 1950s and 1960s, will be reaching the end of their economic lives in the 1990s.

Again, taking copper as an example, the projected lost capacity, based on actual 1984/85 production rates, is shown to the year 2000. It amounts to a staggering 1.277 million tonnes, as shown in table 2.

Table 2

PROJECTED CLOSURES (1986-2000)

Country	Lost Production Capacity (t Cu in conc.)
USA	1,310,600
Canada	178,400
Philippines	202,000
Australia	45,000
Other	541,300
Total	1,277,300

These factors are illustrated vividly in the illustrations of future capacity for copper and gold. Although our detailed projections may be inaccurate in detail because we have used conservative assumptions, the trends they show must be taken seriously. Statistics, however, are like a bikini. What they reveal is suggestive but what they conceal is vital. The statistics given in these graphs are I believe enticing. What is concealed is the changes within and between operations: vital statistics seldom come for free!

Mine Capacity Trends - Copper

Figure 1 plots Brook Hunt's forecasts of western world copper mine capacity to beyond the year 2000. Obviously it is difficult, if not impossible to make any meaningful forecast beyond say 1995, as 10 years is sufficient time to discover, evaluate and develop currently unknown deposits. The

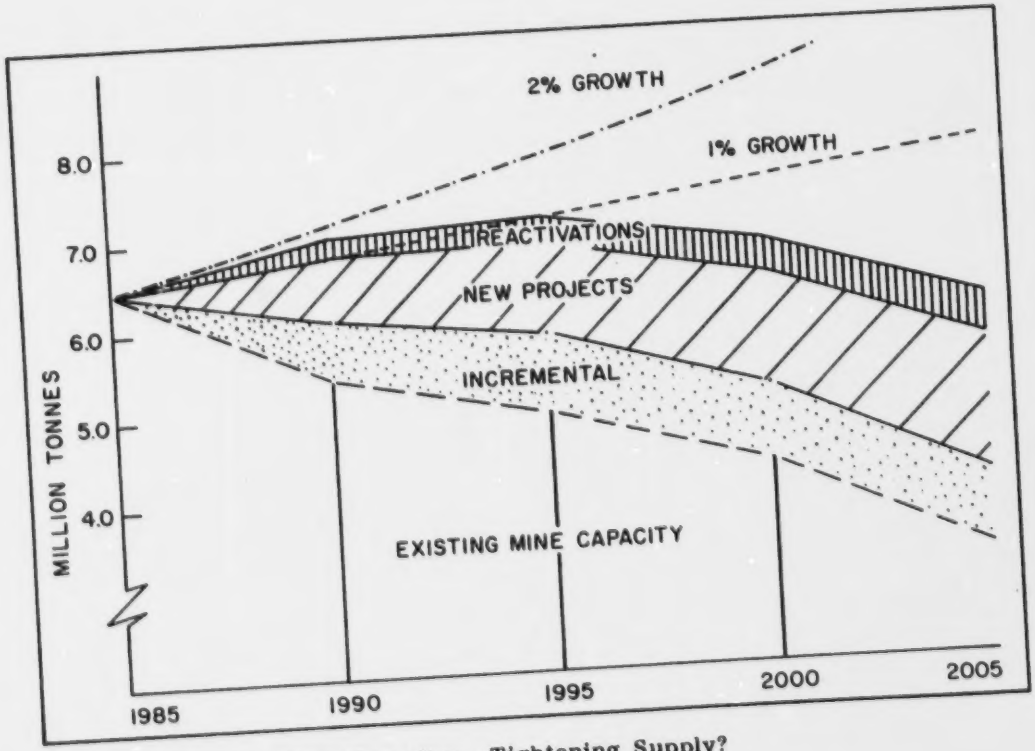

Figure 1. Copper Mine Capacity: Tightening Supply?

analysis to 1995 is done on a mine-by-mine, project-by-project basis and includes careful evaluation of future trends in the underlying cost parameters for existing and possible operations.

Despite the difficulties, we believe the underlying trend to be broadly accurate and certainly worthy of consideration. The figures show that, despite possible reactivations, the average growth in active mine capacity is unlikely to exceed one percent per annum. From figure 1 it is apparent that the main reason for this is the rapid decline in existing capacity. This is projected to fall from just under 6.5 million tonnes of copper currently to under 5.0 million tonnes by 1995.

Thus we are projecting that further closures, plus grade declines, and falling output etc. will reduce existing mine capacity by 1.5 million tonnes in a 10-year period. This is equivalent to a new Escondida every other year.

Clearly, incremental expansions partly offset this decline but, as already discussed, aging mines are less able to expand incrementally. Consequently, by the late 1980s or early 1990s the impact of incremental expansions will fade away appreciably. Our projections suggest that incremental expansions will raise existing capacity by some 800,000 to 900,000 tonnes of copper in the period to 1995, as shown in figure 1.

New projects are forecast to add 1 million tonnes copper to capacity and reactivations could add up to 400,000 tonnes, providing prices rise to levels which justify their reopening, i.e. well over 80c/lb.

Based on the foregoing projections, the net increase in western world mine capacity over the next 10 years is likely to a modest 700,000 tonnes of copper, representing an annual growth rate of only 1 percent. To achieve even this modest growth rate, a significant increase in price to around 80c/lb will be required to bring about reactivations and to encourage financial institutions to commit capital for new projects.

Clearly this suggests a much healthier market is in prospect. Furthermore, all else being equal, it points to a tightening supply situation.

We again stress that, although the detailed capacity projections may prove inaccurate, the overall aggregate picture is likely to be close to the eventual outcome. Certainly it is unlikely that the 1995 capacity projections could be understated by 10 percent and, as you will see from figure 1, this only raises the annual growth rate to just under 2 percent.

Taking a very conservative view of the figures, the conclusion is inescapable that the opportunity for growth and profits lies ahead for the industry. While the transition from a period of oversupply to potential shortage will not be smooth, it could occur more rapidly than anyone is currently prepared to forecast. Two assumptions, however, are built into these forecasts: first, that the mining industry does not repeat the mistakes of the last cycle. The projections assume that only robust, viable projects able to compete effectively within the current and future copper cost profile will be developed. Conversely, that the more marginal propositions are held back to await their slot in the long term demand curve. Second, the forecast assumes that copper prices will remain competitive with alternative industrial materials and that the industry will actively seek to promote copper to ensure it retains its existing markets.

South African Gold Production/Capacity

You will see that the gold data shown in figure 2 has been limited to South Africa. South Africa produces over 60 percent of western world gold, and over half of the total world output.

Two points need to be made before we look at the data presented. First, the graph assumes that production and capacity in a South African context are synonymous. Up to the present, South African mine capacity utilization has always been over 97 percent. Whether this can be maintained in the current difficult environment is an open question.

Secondly, our analysis for gold has deliberately been confined to South Africa. The country's production will continue to dominate world gold supply to beyond the year 2000. However, it must be remembered that, although South Africa has been an important gold producer since the early 19th century, its production is beginning to decline.

What will the trend be in the future? Figure 2 illustrates clearly the rapid decline in South African production beyond the year 1990. It shows also the potential dramatic fall in capacity beyond 1995. By the year 2000, based on Brook Hunt's independent and possibly controversial forecast, gold capacity in South Africa should fall to under 400 tonnes per annum, a decline of 45 percent on current output. The projections to the year 2000 may be in error, and certainly do not take into account the possibility, however remote, that a major new gold field could be discovered and developed in the intervening period.

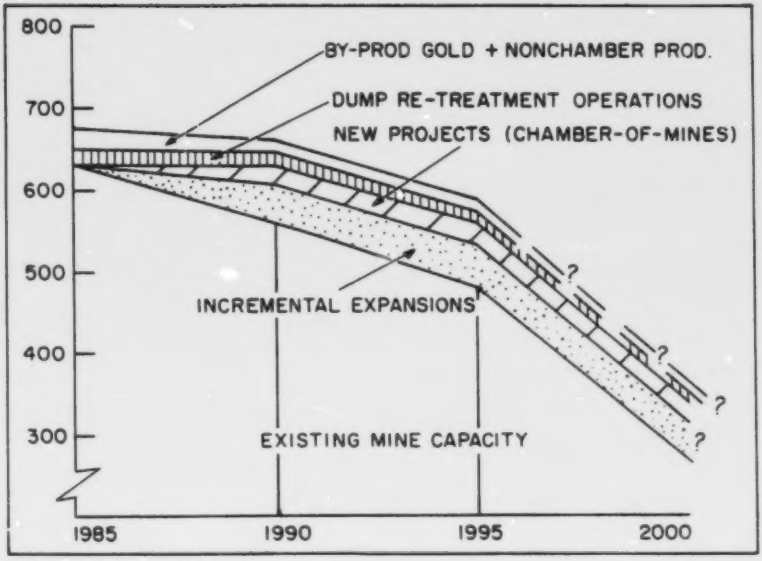

Figure 2. South African Gold Production Capacity: Major Decline Beyond 1990?

The more reliable projections to 1995 show clearly the drop in capacity. Existing Chamber of Mines operations have a current capacity of some 630 tonnes per annum of gold. Excluding incremental expansions and possible new projects, this existing capacity will fall to approximately 480 tonnes per annum by 1995. This rapid decline will be brought about by falling ore grades and mine closures (due to the exhaustion of reserves). Partly offsetting the fall will be incremental expansions which are forecast to add some 55 tonnes per annum and the development of totally new projects which could add a further 25 tonnes per annum.

Despite these important additions, total Chamber of Mines capacity is forecast to fall 11 percent to 560 tonnes per annum by 1995. Similarly total South African capacity is expected to drop from the current 675 tonnes per annum to 590 tonnes per annum by 1995, a decline of 12.5 percent. As figure 2 illustrates, the decline beyond 1995 accelerates rapidly. This trend of falling gold production in South Africa should offer exciting opportunities in other countries.

Production Costs

"In this world all achievements are transitory or at least fragile so we must look at the future", wrote Paul Johnson. And on this note it is important to look at the outlook for production costs. Production costs for most metals have declined substantially over the past four years, an obvious response to weak metal prices. It has been brought about partly by measures taken by the industry, helped appreciably by factors beyond the industry's control. The latter have included currency devaluations, lower energy costs, static or falling wage rates, and a general decline in the rate of inflation. The industry has made major improvements in its overall efficiency, with significant reductions in labour intensity and energy consumption, improvements in inventory and stores control, and so on. It has also been forced to adopt various short-term measures such as high grading, and cost deferments including reduced stripping rates and lower development expenditure.

It is interesting to reflect on the need for greater sophistication in competitive analysis within the metals industry. This is required not only by mining companies but increasingly by banks. Most senior executives in the industry recognize the importance of detailed cost analysis to assess their own competitive position, to evaluate poten-

tial new projects and to understand the overall trends in the industry world wide. At Brook Hunt we have recognized that this alone will not be enough in the future. Our analysis is being oriented increasingly towards a detailed assessment of the underlying cost parameters in order to make meaningful projections into the future. Feasibility studies will increasingly incorporate not only production costs, financial analysis, and environmental impact statements, but also assessments of other even more fundamental variables, such as relative energy intensity and labour intensity. Already the relative capital intensity of a project has become an important development criterion.

So what is the outlook for costs?

While it is probable that labour rates and energy prices will continue to fall marginally over the next few years, for the most part the metals industry faces a period of steadily rising costs, for the following reasons.

i Many operations world wide, faced with weak metal prices, adopted a survival mode with major cost deferments, particularly waste stripping, underground development and capital expenditures. Clearly, if these mines are not to close, a catch-up phase is inevitable.

ii Similarly survival has meant that most mines have been operating to maximize ore grade. Again a cost must be paid. In part this will be manifest by reduction in the economic life of the property, but in the short term more rapid grade declines can be expected with consequential impact on unit costs of the metal product.

iii The massive reductions in the labour force of the minerals industry have largely run their course. Although some minor improvements may be possible and some operations are still over-manned, in general, cost reduction by shedding labour will be difficult to achieve. Consequently, higher productivity will increasingly depend on innovation and capital investment.

iv In those countries which have enjoyed the short-term benefit of devaluations, rising domestic inflation will have an adverse impact on costs. In those countries where devaluation has become an on-going phenomenon, eventually devaluation and inflation go hand-in-hand with little or no impact on costs expressed in

U.S. dollars. For countries which have recently embarked on such a course, devaluations are clearly having an initial beneficial impact on costs, but inflation will rapidly erode this short-term advantage.

v As already discussed, many mines are entering a mature phase. These "old ladies" face rapidly deteriorating cost structures with limited scope for offsetting adverse cost trends by incremental expenses.

vi Another subtle long-term cost factor is arising from the problems being experienced by a number of major underground block-caving operators. With deeper mining, ores have become harder and their caving properties have declined, with the result that a number of mines face a difficult future, possibly having to modify their mining method appreciably with depth, resulting in substantial cost penalties with serious economic implications.

From our observations, mines and mining groups are falling into two distinct camps; those who have a clearly defined long-term strategy to continue reducing costs and improving efficiency, with any short-term measures fully integrated into this overall strategy; and, a second group who are increasingly living from day to day with little or no real grasp of how they will contain costs in the future. This latter group could become vulnerable if another economic downturn occurs in the next few years.

Short-term measures to reduce costs must not be introduced solely on the basis of pure expediency; they must form an integral part of an overall long-term cost reduction strategy. By this means, short-term measures need not be detrimental to the long-term viability of the operation.

A simple example is given. An open-pit operation with severe cost/price pressures was forced to revise long-term mining plans. As part of this revision, the ultimate pit was reduced in size with a consequent small decrease in total available ore. In addition, research had indicated that steeper pit walls were possible in certain sections of the mine and this was also incorporated into the revised plan. The net result was an appreciable reduction in the long-term stripping ratio. As part of an overall strategy it was decided to reduce waste removal immediately, with consequent improvements in mining costs. Crucially, however, this short-term advantage was viewed only as a respite. During the period of lower costs some of the spare equipment capacity was used to relocate future waste dumps,

appreciably reducing future waste haul distances. As a result, total mining costs continued to fall even though the stripping rate had to be steadily increased. We stress that the foregoing example is not intended to teach the obvious; it is presented only by way of illustration. The concept of a fully integrated strategy is a mark of good management.

One obvious result of the difficult period which has faced the industry is that it has focused attention on the absolute necessity for good management at all levels in the industry. It has also underlined the importance of good strategic planning, able to take full account of the cyclical nature of the metals industry. A key feature of such strategies is a rapid flexible response to changing circumstances.

Another aspect is that increasingly, prudent mining groups worldwide are facing the reality that it is not good enough to depend on metal price improvements to solve problems, the problems must be solved by steadily increasing productivity and efficiency. "Plan for low metal prices, hope for higher prices", should be the watchword.

Taxation Considerations

This leads us into the area of tax reform in developed countries which, if fulfilled, could help bring about a renaissance of mining in these countries. Mining can no longer be treated as the "milch cow", to be drained by windfall taxes every time the metal markets pick up and ignored when metal prices plummet and profits turn to losses. Sound policies are needed, based on the cyclical realities of the industry.

Throughout the developed world there is need for a unified sliding scale tax formula for the mining industry, on the lines of that applied to the gold mining industry in South Africa. This formula essentially incorporates two concepts:

- tax rates should vary depending on the level of annualized profitability;

- below a certain level of low profitability, tax becomes negative with a consequent tax rebate (state assistance).

This is illustrated in figure 3.

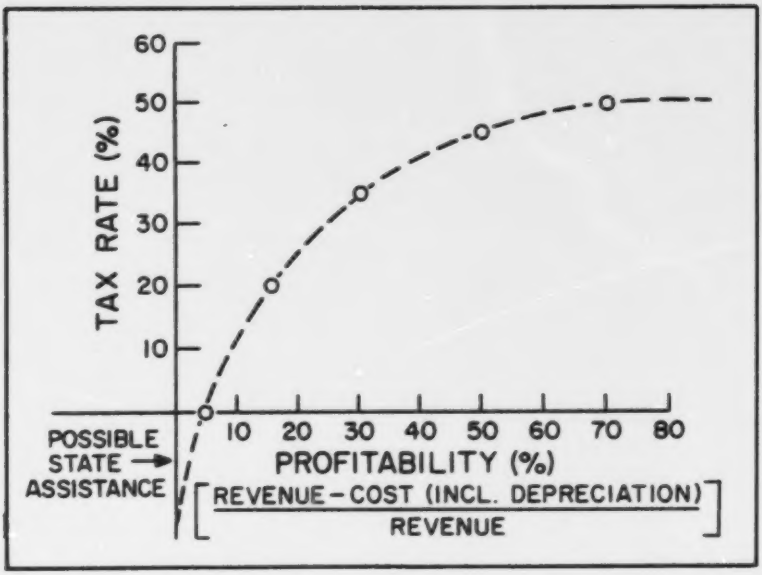

Figure 3. Sliding Scale Tax

The slide shows a possible sliding scale tax curve. Tax Rate is shown on the "y" axis and profitability on the "x" axis. Profitability for this purpose is defined as:

$$\frac{\text{Total Mining Revenue less Costs (including depreciation)}}{\text{Total Mining Revenue}}$$

Various examples are given in table 1.

Table 1

EXAMPLE OF EFFECT OF SLIDING SCALE TAX

				Sliding Scale Tax		Standard Tax	
Example	Revenue $	Costs $	Profit $	Rate %	Paid $	Rate %	Paid $
1	100	50	50	45	22.5	45	22.5
2	100	70	30	35	10.5	45	13.5
3	100	85	15	20	3	45	6.8
4	100	95	5	nil	nil	45	2.3

In example 1, when total costs (including depreciation) are half of revenue, then the tax rate under this possible tax formula would be identical to standard tax, i.e. 45 percent on profits, such that tax would amount in both cases to $22.5.

At 30 percent profitability (example 2), the sliding scale tax rate would fall in this example to 35 percent, compared with 45 percent under standard tax. Tax paid would decline to $10.5 compared with $13.5 under the standard rate system.

The differential increases at lower profitability. At 15 percent profitability (example 3) the tax rate drops to 20 percent, such that the tax paid is less than half i.e. $3.0 compared with $6.8 under the standard regime.

If profitability (as defined) falls to only 5 percent (example 4), that is to say, if costs (including depreciation) total 95 percent of revenue, then the tax rate is reduced to zero. Below 5 percent profitability, there is the possible provision of state assistance, either as tax rebates or even temporary subsidy.

Clearly this description is highly oversimplified. For example, the rate at which capital can be depreciated is not specified. In our opinion this should be entirely at the discretion of the company concerned and should be variable from year to year. No company investing in a mineral project should pay any tax until it has recouped its original investment.

It is appreciated that, in most countries, operating with a standard rate taxation system that includes capital allowances, inventory adjustments, etc. results in a taxation system approximating a sliding scale tax. Nevertheless, the proposed scheme has the advantage of simplicity. It is easily understood by both operators and the public, reducing the likelihood that politicians will get on the "windfall tax" bandwagon. In addition, such a taxation system is a clear recognition by government that taxing a highly cyclical resource industry must be done with great care to ensure the long-term healthy survival of a basic national asset.

Other areas where government can cooperate closely with the mining industry to ensure a better long-term future is the elimination of competition between local taxes, i.e. state and federal taxes. Equally important is the elimination of hidden taxation and excessive front-end taxation. In the latter case we refer to heavy ad-valorem tax, royalties on output, or export taxes. Hidden taxation usually takes the form of import duties on plant and equipment. If the power utilities, railways, harbours etc. are federal or state-owned, it can take the form of excessive charges, well above the world norm. The state of Queensland in Australia charges punitive freight rates to its mineral industry, double the actual cost of operating the railways. This has been a great cost penalty to the base metal operations at Mt. Isa and has made Australian coal appreciably less competitive, with consequent loss of sales, and probably an overall loss in total tax revenues for the state government.

Taxation should be based on the ability of the company to pay. It must be entirely based on profitability, taking full account of the need for large on-going capital investment.

Conclusion

In summary, grade trends, infrastructure, access to capital, security of supplies, and security of assets should be factors which favour investment in developed countries. In

developing countries, however, access to capital has been and will continue to be difficult for all but the most unique projects. I expect the World Bank to get more deeply involved in project financing in Third World countries over the coming years.

All great discoveries are made by men whose feelings run ahead of their thinking. And so the metals industry must meet the challenge of the existing and emerging group of industrial materials. The attack must be two-pronged. First, by continuing to reduce its cost structure through innovative thinking, by further reductions in energy, labour, and capital intensity. Second, the industry must be more aggressive in defending its markets and seeking new outlets under the umbrella of an overall strategic plan rather than by setting up ad hoc arrangements which have a tendency to protect and perpetuate empires.

"In almost all philosophy doubt has been the goad and certainty has been the goal", wrote Bertrand Russell in Portraits from Memory. And should the metals industry be thrust into renewed activity by these doubts about the future, then the goal of growth and prosperity will surely be attained.

STRUCTURAL CHANGES IN THE CANADIAN ZINC MARKET

John J.L. Davies

Canada is the world's largest mine producer of zinc. In 1984 it produced 1.2 millions tons, or 24.3 percent of the free world total of 5.0 million tons. This is down from the 30 percent level we enjoyed in the early 1970s. While production has remained quite static at current levels for some ten years, our percentage of the rising total has slipped. Australia, Peru, Mexico and the United States are our principal competitors.

Table 1

CANADA'S ZINC INDUSTRY

	1984	
	Metric Tons	Market Share
Zinc mine production	1,215,000	24.3%
Zinc metal production	683,000	14.0%
Zinc metal consumption	141,000	3.1%

In 1984 Canada's metal production totalled 683,000 tons, or 14.0 percent of the total free world production of 4.84 million tons. Unlike mine production, Canadian metal production has been increasing. In 1970 we produced 413,000 tons, or 10 percent of the world's total. Europe taken as a whole accounted for 39.6 percent, and is the world's largest single metal producer, followed by Japan with 15.4 percent.

Canadian zinc metal consumption in 1984 was 141,000 tons, or 3.1 percent of the total free world consumption of 4.7 million tons. Canadian consumption of zinc has remained static for ten years.

Table 2

MINERAL PRODUCTION OF CANADA, 1983

	Quantity	Value $ million
Copper (tons)	625,000	1,307
Gold (kg)	70,746	1,186
Iron ore (tons)	32,382,000	1,143
Zinc (tons)	971,000	1,116
All others		2,484
Total metals		7,238

The value of Canadian zinc production in 1983 was $1.12 billion, the fourth highest mineral value produced following copper, gold and iron ore. Exports were valued at $959 million. There are 14 zinc mines and 4 refineries that employ over 18,000 Canadians. By any measure zinc is a large and important business in this country. A careful look at this industry shows that the winds of change are passing over and sapping the vitality of former years. Its market lacks the sparkle and glamour of past years. A loss of vision and confidence about the future has eroded investments into new mines and in this is written serious implications about the future.

Change is the process by which the future invades our lives, and it is important to look at it closely. One way to measure change is to study the past to shed light on the present. Change has been with us from the beginning of time. It is fascinating to study, often difficult to accommodate and generally feared by all. Those of us who cope well with change seem to have a richer, better developed sense of what lies ahead of them than those who cope poorly. Hopefully, this seminar which is focused squarely on the changes affecting our mining industry will give us all a clearer perspective of the future.

The Belgians first identified zinc metal and its refining technology in the mid-18th century. Before the century closed and in the early stages of its industrial revolution, the U.K. discovered how to manufacture brass using Cornish calamine, and quickly acquired dominance of this industry, controlling both supplies and price. The industry prospered through the 19th century. By the early 1900s the centre of gravity of the zinc industry swung from

Europe to the United States, where industrial production was increasing and demand expanding exponentially. Being very well endowed with zinc and sheltered from the ravages of the European wars, the United States rapidly dominated production and price. The industry prospered and expanded through to the 1960s. At that time production peaked, costs rose, technical obsolescence set in, consumption faltered and once again the centre of gravity in the industry began to shift to other markets. Change has left its footprint on this industry throughout history.

Zinc is an industrial commodity and its markets are found in all countries with an industrial base. Historically there has been a close relationship between industrial growth as measured by GNP and consumption. During periods of high growth zinc consumption rises, and during recessions it falls. Because of its broad industrial use, zinc consumption has always been a sensitive indicator of the economic health of a nation. An examination of recent statistics shows that the ratio of zinc consumption per unit of GNP, often referred to as "intensity of use", for all the major industrial economies of the world has been falling, while this ratio is expanding in the developing countries. This is the first important measure of change in the zinc markets, and the causes are due to the following factors:

- The economies of most OECD countries are maturing. As they mature, the manufacturing component of the GNP shrinks relative to the service-oriented sector.

- Manufacturing methods are changing. Industrial technology has become more sophisticated with the growing use of the chip, and electronics use less metal.

- The efficiency of zinc usage has improved with time. This change has been forced on industry by rising costs, particularly for oil, and a desire to minimize the use of materials. Improved design and engineering technology has led to a reduction of weight. Small is beautiful!

- Intense and aggressive competition by sellers of competing materials has led to an erosion of the markets for zinc. The driving force behind the zinc industry has long been production. As a result its marketing skills have lagged.

During the massive reconstruction of Europe and Japan during the 1940s and 1950s, demand for all metals including zinc rose dramatically, particularly in the highly industrialized countries of the OECD as shown in table 3. However, as infrastructure development matured and the birth rate declined, the growth rate in metal consumption in these countries began to ease. Conversely demand began to pick up in non-OECD countries as governments in these countries financed massive programs to raise the standard of living of their citizens through industrialization.

Table 3

FREE WORLD ZINC CONSUMPTION COMPOUND GROWTH RATES
(percent)

	1950-73	1973-84	1980-84
OECD Countries			
Europe	4.62	-0.42	0.08
United States	1.75	-3.14	2.23
Canada	4.23	0.96	1.47
Japan	12.75	-0.50	0.59
Australia	3.75	-3.77	-4.54
Weighted average	3.63	-0.95	0.72
Non OECD			
South America	9.54	3.26	-2.70
South East Asia	10.69	7.21	7.81
Africa	9.23	2.87	0.48
Weighted average	9.96	2.20	5.05
Total free world	4.35	-0.26	1.22

This change has boosted demand for industrial metals and helped to sustain demand. As a result the driving force behind the markets for zinc is again swinging to areas of growth which now lie in the non-OECD countries.

Galvanizing dominates all market applications for zinc, accounting for 46 percent of the total. This market is

growing, partly because other applications have contracted but most importantly because the process has stood the test of time and proven to be the most cost effective method of protecting steel from corrosion. The process is well developed and requires little sophisticated technology. As a result it is widely used in developing countries and is the main thrust behind zinc's rising consumption trend in these countries.

New alloys have been developed to enhance the life of zinc coatings and to keep competing materials at bay. In response from car owners, automobile manufacturers are increasing their use of zinc-coated steel to improve durability from the ravages of salt corrosion. As a result, galvanizing lines in North America, Europe and Japan have operated at capacity for some time, and there is now a massive investment underway in building new lines, mostly using new electrogalvanizing technology.

Diecasting follows at 18.0 percent. This application has lost ground over the past 15 years due to substitution by aluminum, plastics and magnesium, a dramatic increase in imports, technical obsolescence in the diecasting industry and economizing through the introduction of thin-wall diecasting technology. While reducing the weight of a zinc casting, this technology has at least preserved a market. Consumption of zinc by the diecasting industry in the USA has fallen from 35 percent of the market to about 18 percent currently. Much of this change has resulted from the loss of zinc in the U.S. automobile, which has fallen from about 70 pounds per car in the late 1960s to 23 pounds today. The pressure to reduce the weight of the car is one cause for change.

Brass accounts for 19.0 percent of the market. Brass, an alloy of copper and zinc, is a widely used industrial metal having a low value-added component but wide end-use applications. Globally the industry has restructured into a few massive brass producers, mostly located in Europe and Latin America. These plants use the latest state-of-the-art technology to minimize their costs and have effectively forced most of the smaller, high cost, technically obsolete plants out of business. Many of the North American plants have closed so consumption of zinc by the brass manufacturers has fallen.

All other markets are small, reasonably secure from a technical standpoint and slow growing due to changes underway in the markets. For instance, about 7 percent of zinc consumption is used as oxide in the vulcanization of rubber - mostly tires. The steel-belted radials, which have doubled the mileage for tires and significantly reduced

demand for replacements, have obviously affected the consumption of zinc oxide used for this application.

Change always brings with it new opportunities. For zinc this has come from China. This country has announced a new long-term policy to expand its economic base to improve the standard of living of its citizens. The expansion of the infrastructure has begun, and this has turned this country from a modest exporter of zinc into a huge importer. China has turned to the West to meet its requirements of zinc and for the past three years has purchased over 200,000 tons of zinc per year, opening a massive new market for this metal. This new demand has been a lifesaver for the zinc industry.

A few words about the price of zinc might be useful, as price is always a sensitive measure of change. Figure 1 shows that a jump in price in both real and current dollars took place between 1973-74, coinciding with a rise in the oil price.

The most notable signs of change in figure 1 are the following. First, the price in current U.S. dollars averaged 13.8¢/lb. between 1950 and 1973, rising 180 percent to 38.6¢/lb. between 1974 and 1984. Coincidentally with this period, the average real price in 1984 dollars rose from 42.9¢/lb. to 53.1¢/lb. The price averaged 48.6¢ in 1984 and is currently 41.0¢/lb., or 22 percent below the last 10-year average. Between 1950 and 1984 the U.S. price averaged 46.1¢/lb.

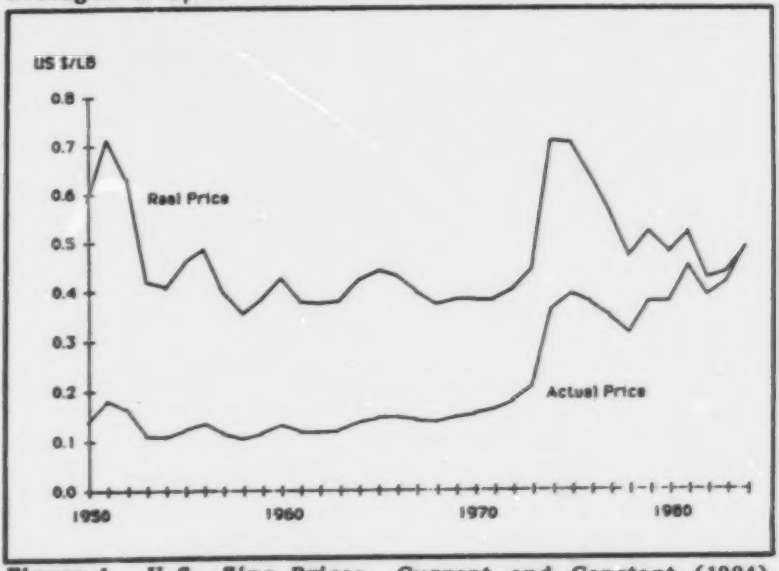

Figure 1. U.S. Zinc Prices, Current and Constant (1984) Dollars, 1950-84

Second, recent deflationary pressures in the market have wiped out the benefits of the real price increase experienced during the 1970's.

Producer stock changes are a sensitive measure of the supply-demand relationship in the market. When stocks rise, prices fall or vice versa. However, this long-term historical relationship seems to be changing: while stocks have been falling steadily since 1982, prices have performed erratically, rising initially with lower stocks but then falling even though stocks have continued to fall. Reasons for this apparent change include:

- the current high cost of money;
- perception in the markets that shortages are no longer likely;
- better management of inventories;
- widespread acceptance of switching, which reduces the pipeline;
- improved transportation services;
- increased consumer access to the global supply sources.

Zinc prices, particularly on the LME, are far more volatile today. Prices commonly change as much as 10¢/lb. in a month, an unheard-of swing ten years ago. Market information today is being transmitted around the world at an increasing speed. This information is available through computer terminals to a vastly expanding, "need to know" market. The result is that we now have a supersensitive market in which small changes in supply-demand relationships can and do lead to unrealistic price swings as the herd instinct takes over.

The relationship between price and currency values is a further factor that has affected the zinc price. The currency used to price zinc world-wide is the U.S. dollar. The result has been dramatic in those countries whose currencies have weakened against the dollar, with the price in some major consuming countries doubling over the past few years.

The treatment charge for zinc concentrate is fixed in U.S. dollars. This has provided a windfall gain for custom smelters located in those countries having weak currencies. As a result, most of the European custom smelters, who suffered years of serious financial losses, are once again profitable. In fact some are now beginning to plan expansions to their capacities.

A careful look at history will show that much of the changes we are experiencing in the zinc business date back to the early 1970s. The oil price increase in 1973 and

1974 was one significant factor. Higher fuel costs led to the downsizing of the automobile to improve fuel consumption through weight reduction. This in turn caused a massive change in demand for materials and labour. While it started with the automobile, the process of change flowed through to other industries. The net effect has been that a given standard of living no longer requires the same amount of zinc as it once did. The result is a classic case of structural change - an irreversible form of change that occurs periodically throughout history and which is often accompanied by social turmoil.

A large part of the rising prosperity and economic performance of the industrial world during the post-war period stem from the fact that real prices for many vital commodities declined. Lower real prices were due to:

- steady investments made into new technologies that reduced the processing costs, improved productivity and the passing of the cost benefits into the markets through price competition;

- the abundance of raw materials, which ensured that the spectre of supply shortages never became a serious reality;

- increasing the economies of scale by increased capital investments.

These factors spurred investment and growth in Canadian mine production, which rose from 280,000 tons in 1950 to a peak of 1.3 million tons in 1977. During the 1970s, a period of high inflation, prices rose but were offset by rising costs, higher taxes, Third World competition, shifts in markets due to closures of obsolete refineries, and a fall in new investment due to unsatisfactory financial returns. As a result growth began to falter. Although production has been maintained reasonably in line with the 1970 levels, Canadian mine production is now in a period of decline, both globally and nationally.

Canadian metal production has held up rather better. Our refineries have benefited from a long period of steady investment to modernize technologies, reduce costs through increased productivity and to comply with Canadian government policies of further processing. Most refineries are now cost competitive with the best in the world, and in addition have the added strength of downstream integration with mines.

There is convincing evidence today to suggest that the longest period of growth and prosperity the world has ever known ended in the late 1960s. Since that time almost every facet of life has been subject to accelerating change. A time of change brings with it uncertainties about the present while the future becomes increasingly more invisible. Zinc, like all metals, is passing through uncertain times due partly to structural change, which I have attempted to identify, and partly cyclical change. The net result has been painful to the business. However, it is reasonable to expect a return to prosperity will recur with an improvement in cyclical change, but structural change will be ongoing and probably intensifying.

The metal has a number of unique properties which industry has successfully adopted for the betterment of mankind. Some uses, such as galvanizing, have a proven record of success and have survived the test of time. The steel producers are the largest buyers of zinc and, although this industry is experiencing extremely difficult times which has resulted in widespread contraction and serious financial hardship to the industry, demand for coated steel products is on the rise. There is now considerable expansion under way in this value-added component of the steel business.

Rising demand for coated steels is not an unexpected occurrence. Consumers today have become more selective and demanding in the products which they buy. Having a greater choice available to them, consumers are seeking out products which have design and quality excellence. The throw-away mentality so prevalent in our society a few years ago is rapidly disappearing, perhaps as a result of rising affluence and the aging society. Zinc adds quality to steel and thus has benefited from the present trend towards quality. I say present because there is no certainty that the future is secure. Nothing today is; and unless an industry is prepared to defend its markets with vigorous promotion and ongoing market development, substitution by competitive materials is a distinct reality.

Zinc's use in die castings is under fierce attack. It has lost an important share of this market and although the metal has superb engineering properties and castability and is truly hard to beat as a die-casting material, it is unlikely to recapture the markets it has lost. The contraction in the business has meant a large loss of people who sell zinc castings, fewer die casting machines available, a loss of technology and skills available to the industry, and some loss in confidence. Retaining the status quo for this mar-

ket will require new technology, new alloys, new investments and the development of new marketing skills - a commitment which I believe the industry will make.

Change has affected some of the other important markets for zinc as mentioned earlier. However, chemicals and related products offer some of the best growth opportunities based on the unique cost effective properties of this metal. An example of a recent success was zinc's acceptance in 1982 by the U.S. Mint for the manufacture of the U.S. penny. As a result, in 1984 the Mint purchased over 45,000 tons of this metal, which was rolled into sheet, stamped into 1¢ blanks and coated with a thin layer of copper before being faced.

A bit of trivia for those interested: There are 181 pennies to a pound of zinc, or 362,000 to the ton. The Mint report that 92 percent of all 1¢ pieces that are placed into circulation disappear immediately after introduction, probably into piggy banks. Stamping 1¢ pieces out of zinc has thus become a unique and valuable market for this metal.

The driving force behind any business is its markets. If the markets are changing, the business has no alternative but to change with them. Canada's strength in zinc lies in its mine production, partly because the country is well endowed with this mineral and also because of our expertise and great mining culture. During the long period of economic prosperity, the zinc industry grew and prospered. In recent years, however, it has become quite fragile, being burdened with high and rising costs, declining ore reserves, unsatisfactory financial performance and almost a total lack of new investments. Its viability is waning and it has started to lose some of its former importance in the market. Zinc is no longer a growth industry in this country. However, judging by existing investments, we will continue to play a key role in the industry and unquestionably should expect some return to prosperity of former days.

A strategy for survival should include the following measures:

- Canada should not seek to expand its mining base unless high rates of return are possible;

- cost management must become the highest priority of any company with realistic prospects of survival - rising costs are a serious problem;

- higher prices are not the answer to rising costs since they give rise to substitution and shrinking markets;

- new technologies aimed at reducing unit costs of mining and higher metallurgical recoveries must be developed if zinc mining in Canada is to remain competitive and economic;

- all levels of government must resist pressures for subsidies to the industry. Subsidies discourage excellence by supporting the weak;

- industry's philosophy must change from production driven to market driven enterprise. Demand for zinc can only be increased through technology transfer and innovation in new products, developed in the research laboratories and brought into the market, along with the promotion of existing markets.

THE WORLD POTASH INDUSTRY - CHANGES IN SUPPLY AND DEMAND

Douglas A. Karvonen

Introduction

Potash is a general term used to describe a large number of potassium-bearing materials. A few of these materials, which occur as soluble salts in bedded underground deposits or as brine in lakes or in seabeds, account for all of the potash produced for use in agriculture and industry.

About 95 percent of potash produced is used as a fertilizer in agriculture. Potassium (K), along with nitrogen (N) and phosphorus (P), makes up the three basic elements necessary for healthy plant growth. The remaining 5 percent of potash is used in industry, initially converted to caustic potash (KOH), which becomes a basic chemical building block necessary in manufacturing a wide variety of products including dyes, paints, insecticides, soaps, television tubes and batteries.

More than 90 percent of potash used in agriculture is produced in the form of potassium chloride or muriate of potash. Most of the remainder is in the form of potassium sulphate or potassium magnesium sulphate. The agricultural potash is manufactured in a variety of sizes and colours depending upon the market and ultimate blending process (either bulk blending or granulation) used to combine it with nitrogen and phosphorus based products. The colour, ranging from red to white, depends on the natural colour of the ore as well as the procedure used for refining. Agricultural grade potassium chloride is generally 95 percent pure or better while the chemical grade is greater than 99 percent.

Scientists decided years ago to express the potassium content in terms of K_2O equivalents and so most potassium products are graded and sold on this basis. Pure potassium chloride is 63.2 percent K_2O and agricultural grades are therefore generally a minimum of 60 percent K_2O. (To convert tonnes of K_2O equivalent to actual product tonnes of KCl it is necessary to multiply by 1.58; conversely, it is necessary to multiply KCl tonnes by 0.632 to get K_2O tonnes.)

Most of the potash produced in the world is first mined conventionally either by blasting or by mining machines. After being hoisted to the surface it is refined

by a series of steps involving crushing, flotation (a wet mechanical process where potash is floated off from the waste, which is largely sodium chloride), centrifuging, drying and screening. Fines are usually dissolved and recrystallized either as separate products or blended with floated products.

Solution mining, by dissolving potash beds with heated brine, is utilized as a production technique by one mine in Saskatchewan (Kalium Chemicals, a division of PPG Industries Canada Ltd.). After the brine is pumped to surface, evaporation and crystallization techniques are used to produce the finished products. This process can be used where beds are too deep to mine conventionally. However, energy costs are a large component of processing costs because of the need to evaporate all the water. The evaporation/crystallization route is used in other parts of the world, such as in France and the Soviet Union, as a refining technique even though the ore is mined conventionally.

The lake brines can be a source of potash in certain parts of the world where the potassium content is high enough. For example, Arab Potash Company in Jordan and Dead Sea Works Ltd. of Israel produce potash from the Dead Sea by using the sun, initially to concentrate the brine in ponds, followed by flotation and crystallization. Similar methods are used by Great Salt Lake Minerals in Utah. Other potential sources of lake brines exist, although they are not large in number. One such lake (Lake Cha-erh-han) in northwest China will likely become a more significant producer in the late 1980s or early 1990s. Electrostatic separation of dry ore is also practised as a refining technique in West Germany.

Known world potash reserves are plentiful.[1] Estimates have placed Saskatchewan's underground reserves alone as adequate to meet world demand for more than one thousand years. Saskatchewan has been estimated to have more than 40 percent of world reserves. Large underground reserves also exist in the Soviet Union. Although less extensive, substantial underground reserves exist in East and West Germany. France, Italy, Spain, the United States, the United Kingdom, Chile, and New Brunswick in Canada all have deposits that are worked for various potassium salts. Substantial reserves are contained in the Dead Sea brines and the brines of Great Salt Lake. Searles Lake and the

1. United States Department of the Interior, Bureau of Mines, Mineral Commodity Summaries - 1985 (Washington 1984).

Great Salt Lake Desert in the United States and the salt lake in Qinghai province in China make up the rest of worked sources. Manitoba in Canada could potentially become a source of potash as a result of reserves which are an extension of the Elk Point basin, and are similar to those mined in Saskatchewan.

Altogether, about 18 sources of potash in 13 countries are being worked.[2] Potential potash reserves, yet unmined, have been discovered in a number of locations around the world including Australia, Botswana, Brazil, Chile, Egypt, Ethiopia, United States (Michigan), Saudi Arabia and Thailand. Some of these will become producing areas during the next decade.

Production

The discovery of potash salts in Germany in about 1840, followed by a recognition of the need for potassium in plants, led to the birth of a modern potash industry in 1861.[3] In two years, the number of plants had increased to 14, and by 1900 over three million tonnes of salts were being extracted. During the early 1900s, potash was also discovered in France and after World War I, French and German companies competed quite aggressively for world markets. Declining prices and profits led the German producers to form a cartel, with the result that they were able to maintain profitability and firm prices.[4]

This first phase in world potash production is characterized by a period of fairly rapid growth, a few suppliers working as a cartel, and stable prices. During the early 1920s the number of active mines operating in Germany was reduced while production continued to increase. Production from Germany reached one million tonnes K_2O in 1927.

What can be designated as the second stage in the development of the world potash industry began in the late 1920s and early 1930s with the first production of potash from Spain, Palestine, Poland, Russia and the United States. Initially production from these new sources was quite small, but as it grew it had its effect on world

2. British Sulphur Corporation, The, World Survey of Potash Resources, Fourth Edition (London, 1985), xiv.
3. World Survey of Potash Resources, xiii.
4. W.E. Koepke, Structure, Behaviour and Performance of the World Potash Industry, Department of Energy, Mines and Resources, (Ottawa 1973) pp. 74-80.

prices. During this period, arrangements were made with the cartel in Europe and prices were stabilized. The world-wide depression and World War II interrupted the production of world potash. With Germany divided after World War II, the United States became the world's largest single potash producer. Most of the U.S. production was concentrated in the Carlsbad, New Mexico area. The emergence of new potash producers in a number of scattered geographic locations and the decline in the influence of the German/French cartel during this period can be considered a significant turning point in the world potash industry. When the United States emerged as a major producer of potash, along with growing demand in North America, the concentration of the industry shifted away from Western Europe.

During oil exploration in the early 1940s, potash was discovered in the province of Saskatchewan, initially at a depth of some 7,600 feet, and later at shallower depths. Until 1951, the Government of Saskatchewan was able to elicit little industry interest in the potash reserves. An early attempt at shaft sinking in 1952 was a failure because of technical and financial difficulties and the project was abandoned due to flooding.

A second attempt was made by Potash Company of America, a New Mexico producer. This attempt was more successful, and in 1958 the first potash ore was hoisted from a mine in Saskatchewan. This mine was later forced to close because of water seepage. It took another six years before it reopened, but it remains in production to this day.

Another company, International Minerals and Chemical Corporation, began attempts to sink a shaft in 1957, and in 1962 the first continuous production of potash from Saskatchewan began.

These early years presented significant technical challenges to the potential Saskatchewan potash producers because of the extreme difficulties encountered in shaft sinking through a high pressure, water-bearing formation known as the Blairmore. While other conventional potash operations that followed experienced some difficulties in shaft sinking, none of these were as severe as those experienced by the first three companies.

By 1970, the Saskatchewan potash industry consisted of ten active potash mines, nine of which were conventional operations and one a solution mine. The ownership of these properties was made up of three categories: those producers which had operations in the Carlsbad area of New Mexico; one company which was owned by French and

German interests; and the third category made up of new entrants which previously had not been involved in the potash industry.

During the 1960s potash production of commercial importance was developed in Italy and the Republic of Congo. Italy still remains a producer, but the mine in the Republic of Congo was forced to close in the 1970s as a result of water seepage.

In 1974 a mine came into production in the United Kingdom. During the early 1970s production expanded quite rapidly in the USSR with major increases from the Byelorussian Republic as well as the Urals region. During the late 1970s, several expansions were made at the mining and refining operations in Saskatchewan.

The Potash Corporation of Saskatchewan, a Saskatchewan provincial Crown corporation, was formed in 1975 and in 1976 began a process of acquisitions. These acquisitions, which took place between 1976 and 1978, resulted in the corporation acquiring approximately 40 percent of the productive capacity of the province, giving the corporation sole ownership of three potash mines, 60 percent ownership and operating responsibility for a fourth, and acquiring ore reserves and a production agreement for about 25 percent of the production from two mines of International Minerals & Chemical Corporation (Canada) Limited. The acquisitions followed a long period of negotiations and legal actions surrounding regulations and taxation levies established by the government of the day.

With the expanding markets of the late 1970s, PCS proceeded with expansions at four of its five divisions. Additional expansions were planned which included a new greenfield potash mine. However, the world-wide recession and downturn in potash markets in 1981 forced cancellation of these additional projects.

During the late 1970s some minor expansions were also made by the mines owned by the private sector in Saskatchewan. All of the expansions by PCS and other companies operating in Saskatchewan (with the exception of the PCS Mining Rocanville Phase II Expansion of approximately 600,000 tonnes KCl completed in 1981, and the Lanigan Phase II Expansion of approximately 2 million tonnes KCl which will be complete in 1985) have been of the bottlenecking-type of between 150,000 to 400,000 tonnes KCl per annum. The productive capacity of the Saskatchewan industry is presently about 13.7 million tonnes KCl, or 8.3 million tonnes K_2O and this capacity is owned by seven companies, which represents approximately 28 percent of the world's productive capacity. Industry sales grew to more

than 7.0 million tonnes K_2O with a value of about $1.0 billion in 1980. Some decline in sales and revenues as a result of the world wide recession have taken place since then although there has been a recovery in 1983 and 1984 (figure 1).

In the 1980s several new regions came into production, in addition to expansions in Saskatchewan, the USSR and Israel. These are Jordan with production from the Dead Sea brines and the province of New Brunswick with two conventional mines which are both still in the start-up phase. A project in Brazil is scheduled to begin production in 1985.

In 1984 world production was about 29.5 million tonnes K_2O. The following is an approximate breakdown: USSR 33 percent; Saskatchewan 26 percent; East Germany 12 percent; West Germany 9 percent; France 6 percent; United States 5 percent; Others including Israel, Jordan, China, Latin American, Spain, Italy, and the United Kingdom 9 percent.

What could be described as the third period of major change in the world potash industry was the beginning of the Saskatchewan potash industry in 1962, followed by the fairly steady and rapid increase in production up to 1981, which could be considered the end of the period. During this period Saskatchewan producers became major factors in world export markets as 95 percent of all Saskatchewan potash is exported outside of Canada.

Probably 1981 marked the beginning of the fourth period of structural change for the potash industry. It has been characterized by fluctuating production rates, resulting from unstable world markets, as well as the entry into the industry of new producers in Jordan, New Brunswick and most likely, Latin America. Resources have been discovered in many parts of the world and while some of these deposits will be difficult to develop, plans for their exploitation continue. Some of these discoveries are in less-developed countries where governments are very interested in seeing these developments, in some cases for the foreign exchange earnings that might be saved by domestic production of a vital resource, but often as not for the foreign exchange to be made.

World potash production, which grew at an average rate of about 7 percent per year during the 1960s and 1970s, has shown very little growth in the 1980s. In fact, world production fell about 12 percent in 1982, recovering to a new record in 1984. Capacity increases, based on forecast growth rates for demand which were much higher and planned for the late 1970s, are presently coming on

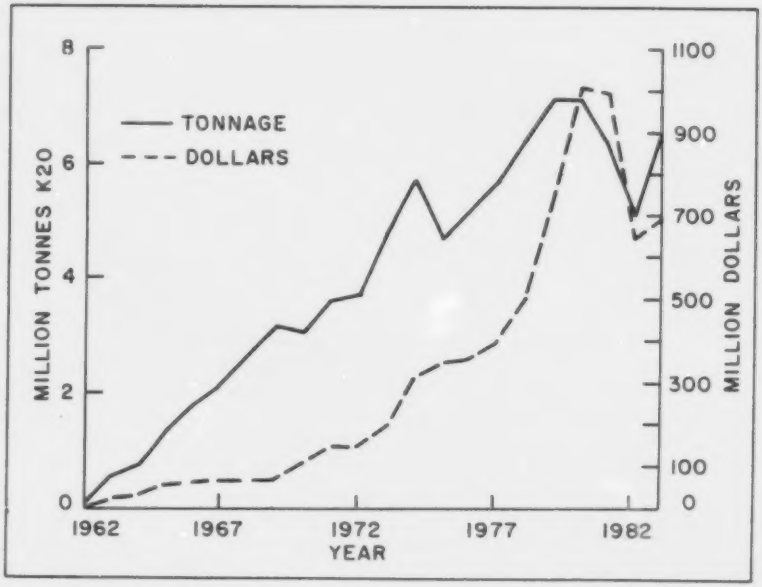

Figure 1. Saskatchewan Potash Industry Sales, 1962-83

stream. Production capacity is likely to continue growing at 5 to 6 percent a year until 1988 when most of the expansion plans now committed will be completed and available.

Demand

During the first two stages in the development of the world potash industry, demand was largely centred in Western Europe. Eastern Europe and North America began to emerge as markets in the 1930s. It was not until the latter part of the second period, during the 1950s, that the early signs of export potential in Asia (Japan) became apparent.

Throughout the first two periods and until the mid-1960s, demand was adequate to take all of the production available. The two World Wars created disruptions, of course, but available information suggests that the industry was profitable during this period.[5]

During the 1960s the Green Revolution resulted in a steady 6 to 7 percent per annum growth rate in world potash demand. The growth rate continued on into the 1970s at a fairly consistent rate except for some disruption created by the OPEC oil crisis in 1973. With the exceptions of Western Europe and Japan, which began to show signs of becoming a mature market during the early 1970s, demand grew in most regions of the world.

While demand growth was strong during this period, a severe oversupply developed in the late 1960s because of the sudden expansion of capacity in Saskatchewan. In 1969 the Government of Saskatchewan brought in a potash prorationing program in an attempt to halt the sliding prices and regulate production. The program had the desired effect of raising prices and was operated for approximately three years until potash demand began to catch up to production capacity and the program was disbanded. The recovery in potash prices placed against a background of rapidly rising oil prices and general upward revisions to resource taxation in several parts of Canada resulted in the Saskatchewan government applying a taxation levy called a Reserve Tax in an attempt to capture a portion of these new revenues. Although modifications were made to the tax and royalty scheme in the late 1970s, the modified system (called the Potash Resource Payment Agreement) is still in effect. In 1983/84, it raised approximately $40 million in

5. Structure, Behaviour and Performance of the World Potash Industry, pp. 48-51.

revenues for the provincial government. This payment is quite sensitive to potash price and the revenue collected by the provincial government is down substantially from the period of peak prices in 1980 and 1981.

By 1981, the impact of the world wide recession and the huge grain surplus in the United States resulted in the U.S. government bringing in an acreage reduction program called "Payment in Kind" which resulted in a dramatic drop of nearly 20 percent in potash sales to North America in 1982. This event and the world wide recession signalled an end to the generally even growth which had been experienced in world potash consumption.

Because of the weak demand in the USA and the financial problems of Latin America, there was no growth globally between 1978 and 1983. Although 1984 appeared to set a new record at about 28.3 million tonnes K_2O, the current outlook is not very encouraging. Broken down by region, demand in 1984 was as follows: East Europe 36 percent; West Europe 22 percent; North America 21 percent; Asia 12 percent; Latin America 6 percent; Africa 2 percent; and Oceania 1 percent.

Structural Change During the 1980s and the Future

So far, this paper has devoted considerable attention to describing the world potash industry and the major events which have in the past signalled the beginning of permanent change. The rest of the paper will attempt to describe the present period which began in 1981 and project where the industry is heading.

Simply stated, the situation facing the industry today is difficult. It includes the following:

- an economic crisis in North American agriculture;
- a heavy debt load and weak purchasing power in less-developed countries;
- a growing tendency towards countertrade;
- oversupply of potash resulting from demand forecasts that were too optimistic, aggravated by totally new supply sources which must develop their own distribution channels;
- a rising interest in protectionism in the United States.

North American agriculture is itself in a period of major structural change. Grain producers are facing a very competitive market as a result of increasing exports from the European Economic Community, Argentina and Aus-

tralia. Meanwhile, countries that used to be major importers, such as India and China, no longer require grain because of the success of their own agricultural policies and could, in fact, become an export threat. The result is a flattening out and perhaps even a drop in grain trade while more suppliers become a factor.

Domestically, a switch away from beef, veal and pork consumption toward poultry and fish means weaker demand.

Weak prices and volumes, coupled with a high debt structure from investments in farm assets at inflated prices, have meant that net farm income, as well as gross income, has dropped dramatically from the 1970s. Uncertainty surrounds the nature of U.S. farm support programs which have become a costly drain on the treasury without producing the healthy farm economy which was their objective. Indications are that a large percentage of farms in the USA will go bankrupt and that perhaps 20 to 30 percent of land will be taken out of production.

The United States accounts for 55 to 60 percent of Saskatchewan potash sales and the Saskatchewan industry has about 75 percent of the market. This potash is used largely to grow corn and soybeans. Fertilizer consumption is likely to drop at least 5 percent with zero growth for several years even though more productive land will be farmed more intensively. Without unforeseen events, U.S. potash consumption, which represents 95 percent of North American consumption, is likely to plateau and unlikely to recover to the record of 1979 until the middle of 1995.

Offshore, the situation is varied although only slightly more optimistic. Western Europe is a mature market likely to show little overall growth. Eastern Europe has more growth potential but is unavailable to non-East European producers because of the production in East Germany and the USSR, both of which are net exporters to most markets available to other producers. Africa is unlikely to provide much in the way of growth because of political instability and lack of strong agricultural development policies in most areas. Oceania is a small market and its technology is well developed so that a small growth rate will have little impact on volume.

That leaves Latin American and Asia as the major growth areas. Cuba and Brazil are the major markets in Latin America. Cuba is largely locked into East European suppliers. Brazil represents about 65 percent of the market in this region and has good growth potential. Consumption grew quickly in the late 1970s, but the debt crisis brought this to a halt in 1980. A major drop in consumption took place between 1981 and 1983, with some recovery

in 1984 and 1985. A new potash mine will eventually meet some of their own requirements. It remains a very competitive market, with GDR being the base supplier through bilateral trading relationships and favourable financing. Growth in Brazil could be in the order of 8 percent per annum with perhaps 6.5 percent for the region as a whole during the next decade. Its financial problems have not yet been totally resolved.

The other growth market is Asia. India has emerged as the largest market and the country with the most stable growth rate. Japan is a stable market, but it has no growth potential because its agriculture is likely the most intensive in the world.

China appears to have the largest volume potential of any country in Asia. While its apparent consumption rivaled India's in 1984, it has yet to become a steady growth market as its purchasing pattern over the last decade has been very erratic. For example, it purchased most of its needs from Canada in 1984 with some 700,000 tonnes KCl. In 1985 it has not purchased anything. Considering that such a sale represents a 65-percent operating rate for a typical Saskatchewan mine, China's absence as a buyer is significant. Other markets in Asia with growth potential include Indonesia, South Korea, Malaysia and the Philippines. As a whole, Asia should grow at 4.5 percent per annum during the next decade, recognizing that the overall growth rate will depend on China.

The debt crisis and lack of foreign exchange facing some of the countries in Latin America and Asia have forced them to adjust their agricultural policies negatively, as well as reduce purchases except under the most favourable financing terms or countertrade.

Countertrade can take place in several ways. It can be conducted under a bilateral trade agreement between countries, a method which has been used by East Germany; through tenders involving both purchase and sale of commodities, as has been the case with Indonesia; or it could be a preference for suppliers that purchase quantities of the buying country's goods, as recently introduced by India. Regardless of the mechanics, it is a growing factor in world trade.

One of the problems which has been a continuous issue since the mid 1960s is oversupply created by expansion of the world industry based on forecasts which have always been too optimistic. Hopes for the Green Revolution, which led to the potash oversupply of the 1960s, never materialized and the capacity installed was not utilized until the late 1970s. Expansion plans initiated during the latter

period, coupled with a drastic cutback in demand estimates for the 1980s following the recession, mean that the industry will be in a serious state of oversupply until at least the early 1990s. If new supply sources now planned in some of the developing countries as well as Manitoba, New Brunswick and Michigan proceed, the oversupply situation will continue well into the 1990s.

A review of world supply/demand estimates suggests caution in basing expansion plans on estimates more than five years into the future (figure 2). There is no historical basis to believe they will be anything but optimistic. Indeed, the FAO/World Bank Working Group estimates, which form the basis for many forecasts, should be regarded as optimistic by definition, given that their objective is to ensure adequate supplies of fertilizer are available to maximize world food production.

Once new supply sources are on stream they remain there until costs cannot be recovered over a period of time. The length of this period will depend on the financial resources of the owner and its view of the future. As a large proportion of the world potash industry is state owned, the timing of closure can be further complicated and is difficult to predict. New supply sources in the current environment will also have a destablizing effect on prices.

Protectionism in the USA is also a threat to free trade in potash. The U.S. producers in New Mexico, with ore deposits and costs higher than those experienced by some other producers, have been under pressure since the mid-1960s. Several producers have closed or cut back operations and today production is about one-half that in the early 1960s. During the last year, all of the operations except one have been available for sale or have changed ownership, a clear indication that their current or previous owners do not anticipate improvements in the future.

This threat to the U.S. industry has resulted in a number of initiatives designed to delay closures or protect the remaining industry. These steps include attempts by ad hoc committees organized by the City of Carlsbad, New Mexico to investigate possible action that might be taken; Congressional public hearings chaired by Senator Domenici of New Mexico; and petitions to the U.S. Department of Commerce and International Trade Commission by two Carlsbad area producers for imposition of anti-dumping and countervailing duties against potash from Spain, GDR, USSR and Israel. While the results of these actions so far have been minimal, they, along with similar attitudes by the USA toward other imported commodities, suggest yet another risk for the world potash industry.

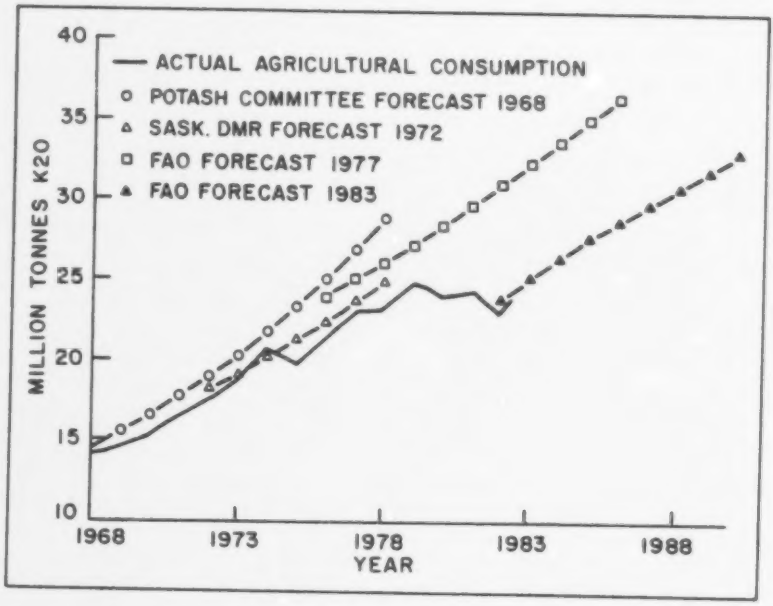

Figure 2. Forecast vs. Actual Potash Consumption, 1968-90

Conclusions

A number of conclusions can be drawn from a review of the present situation.

1. The potash industry will be forced to rationalize or close production capacity to deal with the overcapacity. This should be the high cost producers, but may not be because of protection provided.

2. Until rationalization of production takes place, weak prices will prevail. North American prices in current dollars are as low today as they were during the mid-1970s. Producers outside of North America are benefiting from a strong U.S. dollar which is insulating them from a cost squeeze.

3. Potash demand will again fall short of current estimates of expected demand (figure 3). A demand growth rate for the next ten years of 2 percent per annum is probably realistic. The period of oversupply therefore will be longer than anticipated.

4. The world industry will be under extreme pressure to reduce costs. New suppliers will find entry into the market difficult even if they can meet the unlikely criteria of accessible, high quality reserves, superior technology and close proximity to growth markets. This last condition is very significant because potash is a low-value bulk commodity for which transportation can make up as much as half the delivered cost. A look at freight rates and FOB mine netbacks in Canada suggests that railways have been much more successful at maintaining a price structure to recover increasing costs than has the industry (figure 4). Freight costs must be kept low to maintain a competitive industry.

5. The potash industry in Saskatchewan has the ability to expand its capacity at one half to two-thirds of the cost of a large greenfields project with less lead time. When capacity is required, it can be added at most of the operations in the province in small increments. New technology will enhance this ability. New potash projects, at least in Canada, cannot be justified in the foreseeable future on a normal rate of return basis.

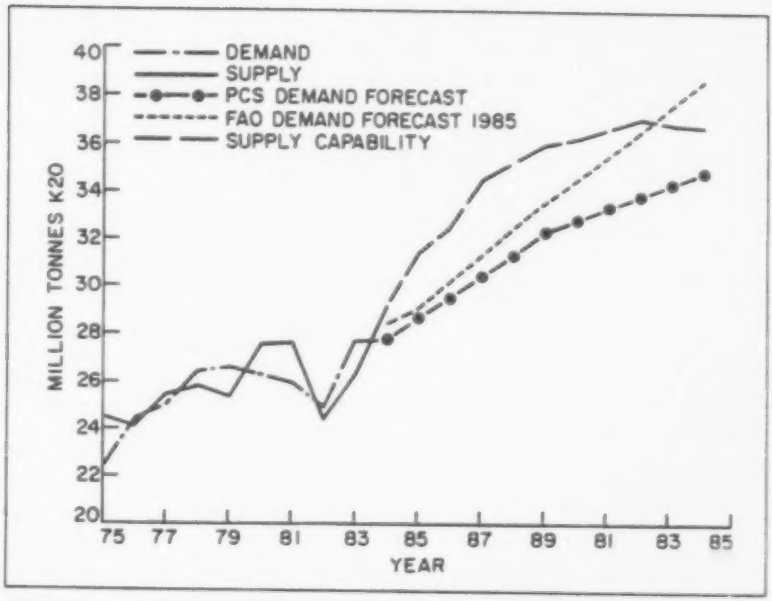

Figure 3. World Supply and Demand, 1975-95

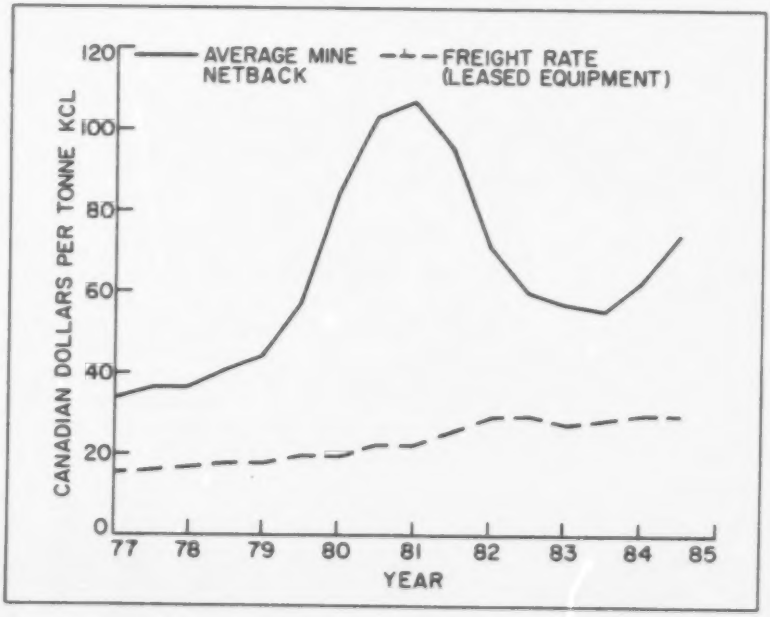

Figure 4. Saskatchewan Export Netbacks vs Freight Rates to Vancouver, 1977-85

6. The new economic environment means the Canadian industry must learn to compete more aggressively in the global market. New markets must be developed and serviced. For example, this may mean that countertrade will become an increasing part of conducting business. CIDA funding has been of great assistance in developing markets in India, Sri Lanka and Indonesia. CIDA's participation in an agronomic development program jointly with the Government of Saskatchewan and the industry to demonstrate the benefits of potash in China will ultimately result in more consumption. Such funding must be continued.

   Saskatchewan potash is sold offshore through a producer-owned company called Canpotex Limited which provides good sales and transportation economics to the industry. To survive and grow this company must be aggressive in its sales program and accommodate the more complex environment of the present. A customer's needs must be met. The alternative is not to be in business.

7. Finally, governments must be careful not to place too many demands on the industry for economic rent. At least in Saskatchewan, these expectations have always been high. A number of economists have attempted to determine whether the rent has been maximized.[6] While the debate is interesting and the revenues raised have been substantial, the possible negative implications for the long-term health of the industry and growth potential cannot be overlooked. It may be that the payments extracted are too high and that as a result jobs and investment are lost.

In summary, the world potash industry is at the beginning of a fourth period of structural change since its beginning. The industry, at least in North America, is presently having difficulties. With a more aggressive marketing effort, some attention to the errors of the past and a strong program for R&D and development, it will emerge stronger. This is particularly true for Saskatchewan which has the reserves to meet demand for at least a thousand years.

---

6. David L. Anderson, Discussion Paper No. 264, The Saskatchewan Potash Industry: Alternative Strategies for Future Development, Economic Council of Canada (Ottawa 1984).

THE IMPACT OF TRADE POLICIES ON CANADIAN MINERALS

Germain Denis

Before narrowing the focus down to minerals, it is worth taking a little time, I think, to set trade policy into a more general Canadian perspective. The bottom line is that trade and trade policy have contributed significantly to Canada's development as a nation and to the evolution of our economy into one which is modern, diversified and well integrated into the world scene.

The Role of Trade Policy

Throughout the post-war period, Canada's trade policy has been consistently oriented toward seeking improved access to larger markets for Canadian goods and services. This, in turn, has encouraged a substantial degree of international specialization and provided for a more competitive and stimulating environment within the Canadian market. Overall, as a fall-out from Canada's participation in seven post-war rounds of trade negotiations under the General Agreement on Tariffs and Trade (GATT) and various other initiatives, Canadian producers now benefit from very significant opportunities to increase their productivity through sales, not only in the relatively limited Canadian market, but also in the USA, Japan, the European Community and the rest of the markets of the world.

But trade policy is not simply a matter of opening up markets to the freer flow of goods and services. However important that aspect may remain, trade policy plays other roles. Market access, once achieved, needs to be secured or safeguarded. The GATT itself plays a very significant role in this regard, as do the various nontariff barrier agreements negotiated under GATT auspices. Bilateral trade relations and initiatives that enhance them are also important players. An effective trade policy also looks at ways of improving the functioning of the international marketplace, and of dealing with any distortions to competition which may exist or arise. Finally - and of periodic direct relevance to metals and mineral producers - trade policy considerations play a significant role in the regulation of either injurious imports or strategic/sensitive exports.

The Significance of Resource Sectors to Canadian Trade Policy

Exploitation and transformation of the products of Canada's resource base - whether the sea, the soil, the forests or the mines - has consistently been a foundation for industrial development. The development of export markets has been a priority concern over the years in the conduct of Canada's trade relations with many other parts of the world, but especially the USA, Japan and Western Europe.

This is particularly the case for ores, metals and the processed or fabricated products of our mineral endowment. The strong export orientation of the metals and minerals industry in Canada has meant that, along with agriculture, fisheries and forest products, the resource-based sectors have had a determinate influence on Canada's position in trade negotiations in particular, and trade policy approaches more generally.

Canada remains among the world's largest exporters of aluminum, nickel, zinc, asbestos, molybdenum, gypsum and platinum. Exports of metals and minerals still exceed 20 percent of total Canadian exports; Canada also imports important quantities of minerals such as bauxite, coal and iron ore for use in the iron, steel and aluminum smelting industries.

Something in excess of 80 percent of these Canadian mineral exports is in the form of crude materials and primary metals, and it is not surprising that industrial diversification and development aspirations of various regions and communities across the country are tied to the prospects of raising the level of production of these resources in Canada.

The 1960s and 70s saw an erosion of Canada's overall share of several world mineral commodity markets. Through the 1980s the supply/demand balances may begin to be restored as economic recovery occurs, but slower international rates of economic growth seem to hold the promise of only modest growth of world consumption of metals and minerals.

Canadian producers can nevertheless be expected to remain a major factor in international mineral commodity markets, particularly for nickel, copper, zinc and aluminum. Similarly, Canada may be expected to become an important factor in the world thermal coal market.

Canada's favourable resource base and reputation as a politically stable and reliable supplier of resource commodities should serve Canadian producers well in maintaining their shares of world markets. Moreover, although overall world supplies for major minerals may be relatively abund-

ant in present economic circumstances, major industrialized countries remain heavily dependent on imports of industrial raw materials and concerned about ensuring stability and security of their supplies.

During the 1973-79 Tokyo Round of multilateral trade negotiations, metal and mineral products received high priority attention from Canadian negotiators. The results, while perhaps less far reaching than had been hoped at the outset, were nevertheless a very considerable accomplishment. Overall, looking at the average for all major industrialized countries (Canada included), the tariff rates on metal semi-fabs, for instance, were negotiated downward by about 30 percent. Coupled with similar results from previous negotiating rounds, this means that such rates now average below 5 percent. For articles of metal, the average residual protection in industrialized countries is now around 6 percent, down from almost 10 percent at the start of the Tokyo Round. There was also some success registered in bringing nontariff measures under better discipline and in reducing or eliminating their impacts.

Just as averages and generalities mask the reality of a particular duty rate which stands as a barrier to shipments of a particular product, so some of the specific accomplishments of past negotiations fade into the recesses of memory. People forget, for instance, that an important reason behind Canadian ores, concentrates, potash, sulphur, and many fertilizers moving essentially unimpeded by tariff barriers is that duty-free access was bought and paid for in the course of earlier negotiations. It is, I think, also worth recalling some of the specific concessions agreed upon during the Tokyo Round and right now in the final stages of being implemented. The U.S. rate on aluminum ingot, for instance, was negotiated to "free". The USA also agreed to cut its tariffs on most asbestos products to "free". Its rate on magnesium ingot, 20 percent at the outset, will reach 8 percent after the end of next year. The tariff on the main manufacture of gypsum (i.e., wallboard) was also agreed to be cut by 60 percent and will be less than 2.5 percent after the end of next year. The USA also agreed to reductions in the area of 40 to 50 percent for such semi-manufactures as pipe, bar, rod, plate, sheet, etc., most of which will face duties in the 4 to 7 percent range after the end of next year. There were also some less striking reductions agreed to by the European Community and Japan. Canadian exporters of semifabricated nickel, aluminum and copper products to Europe will now face duties in the 4.5 to 10 percent range, down from the 6

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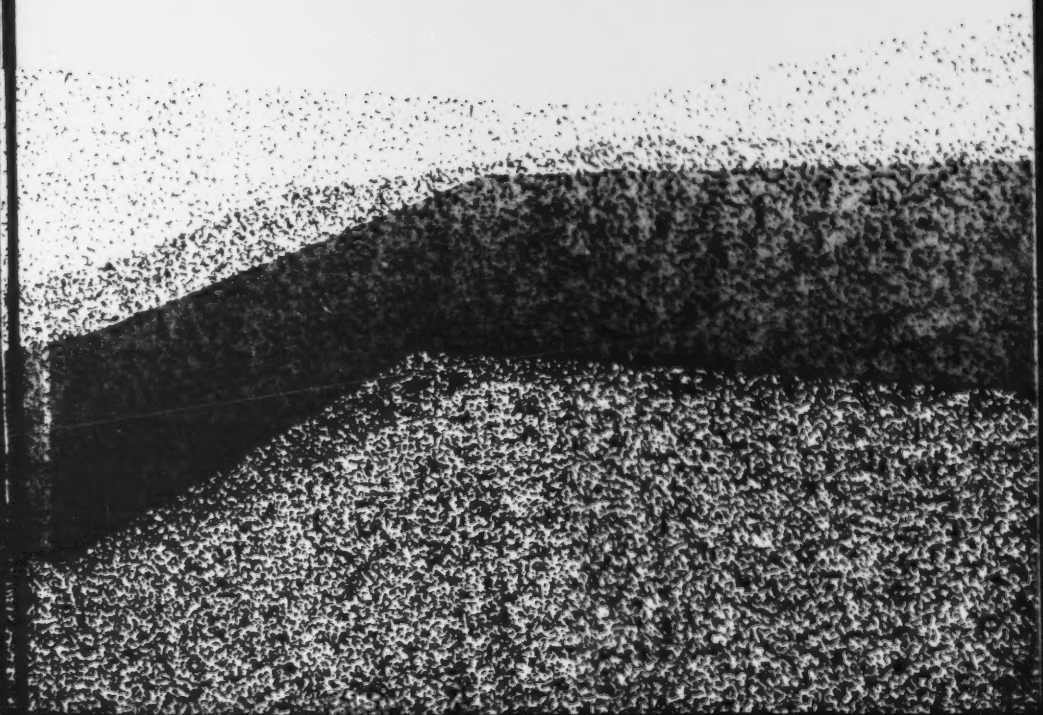
Queen's University
Kingston, Ontario

Structural Changes in the World Mineral Industry: Implications for Canada

Proceedings No. 18

Edited by
M.J. WOJCIECHOWSKI



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STRUCTURAL CHANGES IN THE WORLD MINERAL INDUSTRY: IMPLICATIONS FOR CANADA

Proceedings of the
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FOREWORD

This volume contains the proceedings of the 15th CRS Policy Discussion Seminar. The CRS seminar series brings together individuals from industry, governments, labour, universities, and other organizations to share their knowledge and views on selected issues in mineral policy.

Structural changes over the last decade or so have profoundly and permanently changed both supply and demand patterns in world mineral markets. The seminar looked at these changing patterns, both in general and for several specific commodities, discussed related economic, trade and currency-related issues, and identified strategic responses which have been taken and might be taken in future to assist the Canadian mineral industry in adjusting to the new circumstances.

The seminar was held at the Donald Gordon Centre for Continuing Education in Kingston on September 9-11, 1985. The program was arranged by Peter Richardson of Queen's University School of Business, in consultation with CRS. The proceedings volume was edited by Margot Wojciechowski and produced by Donna Beaubien.

The Centre is grateful for the contributions of the speakers and participants, both during the seminar and in the preparation of the proceedings. Views expressed are those of individual participants, and do not necessarily represent the views of the Centre or its sponsors.

Margot J. Wojciechowski
Centre for Resource Studies

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STRUCTURAL CHANGES: IMPLICATIONS FOR CANADA

Major changes have taken place in the structure of the world's mineral industries which have significant implications for the mining industry in Canada. While there is considerable work in process to measure these changes and understand their impact, the problem is far from being well understood. The purpose of this CRS Policy Discussion Seminar was to further understanding of the process which is under way, and develop policy recommendations which will enable Canada to meet the challenges effectively and to take advantage of opportunities arising from these changes.

Papers and discussions in the first part of the seminar dealt with changing patterns of supply and demand. Demand for many minerals is being affected by declining growth rates in existing markets and substitution by new materials. New markets, often with substantially different requirements and product characteristics, are emerging. Accompanying these demand changes are altered patterns of supply. Structural shifts are taking place in the world mineral industry which challenge Canada's position as a leading producer of many mineral products. Case studies of lead and zinc as well as potash cite specific industry examples of these challenges and their impact.

The structure of Canada's mining industry in the future will be, to a great extent, determined by the general economic climate. In the second part of the seminar, papers were presented addressing the general economic outlook for mining, trade policy, and the impact on the industry of currency fluctuations. In the United States, these factors have combined to play a key part in the recent decline of the mining industry in that country. Given the high export orientation of Canada's mining industry, these factors will play a key role in determining its future structure and share of world mineral trade.

The final part of the seminar presented alternative views of what actions might be taken to adapt to these structural changes. Papers were presented by federal and provincial governments, as well as private sector representatives. In addition participants brought forward their own experiences and views in a final plenary session and throughout the seminar, and these are restructured and summarized in the digest of discussions. A closing summary was provided by Keith Buck, former Secretary-General of the International Lead and Zinc Study Group, who has had substantial practical experience in dealing with structural change in this key industry.

KEYNOTE ADDRESS: STRUCTURAL CHANGES IN THE WORLD MINERAL INDUSTRY: IMPLICATIONS FOR CANADA

Phillip Crowson

Introduction

It is worth starting with a question of semantics: what, precisely, is meant by structural change? The phrase is often used to distinguish some kinds of change from the cyclical developments which are regarded as reversible features of the business cycle. Does this mean that we are discussing changes which are likely to prove permanent? Some changes which have been treated as structural will in time be reversed, so that we may be merely talking of long-run rather than short-run cyclical movements. Of course, a terminally ill patient, as much of the mining industry presently seems to be, may not be too interested to know that his condition is only temporary, when its conclusion is likely to be his demise. Yet we have to recognize that mining has always been a dynamic industry, as the grassed-over spoil heaps and ghost towns of abandoned mining areas throughout the world bear witness. Change has always been a feature of the mining business. Economists distinguish between cyclical and secular trends, the latter being defined as "those continuing over vast periods of time". Many of the recent changes in the mining industry, which have been described as structural are in truth secular. Other changes which may have appeared to be very sudden may not be genuinely structural in nature.

These questions, which could be multiplied almost ad infinitum, are highly relevant to this seminar. A failure to diagnose changes correctly may well lead to faulty prescriptions. In any case, this paper will concentrate on structural changes in the world mining industry rather than on their implications for Canada. Perhaps these implications can be summed up very briefly in Adam Smith's remarks over two centuries ago about the world always beating a path to the door of the man who builds a better mousetrap.

The roots of the mining industry's present difficulties lie in the extraordinarily sustained post war economic boom. This historically atypical period of 25 years of rapid economic growth without serious cyclical disturbances engendered firmly held beliefs about the inevitability of

progress. Exchange rates were reasonably stable under the Bretton Woods System, and world trade flourished as the controls of the 1930s and 1940s were progressively dismantled. An entire generation of managers and officials grew up who had never experienced different economic conditions. Investment plans were formulated in the confident expectation of continued growth, virtually underwritten by governmental policies. There might be the occasional pause but it would be only temporary, and it would be relatively easy to pass on cost increases in higher prices.

The devaluation of the U.S. dollar in 1971, the cyclical excesses of 1972-74 and the rise in oil prices associated with the Yom Kippur war severely dented expectations but did not dispel them. It was recognized that the world economy had suffered a series of shocks, and that growth might be temporarily delayed, but it was widely believed that normal service would be resumed relatively quickly. The last decade has seen harsh reality intrude on those illusions, which no doubt most of us shared in varying degrees.

Demand for Metals

Much has been written on some of the changes on the demand side of the minerals industry, but the comment appears to concentrate on the symptoms rather than the causes. Thus falling "intensity of use" is trotted out with monotonous regularity, and to the point where even Australian cabinet ministers can authoritatively quote the Japanese phrase "Kei Haku Tan Sho", or "lighter, thinner, shorter, smaller". It bears repeating that intensities of use of most metals have fallen in the developed countries for many years. Recent experience is by no means out of step with historical trends. Consider copper, for instance. Particularly in the United States there is some evidence of cyclical variation around a generally declining trend; a trend that has been in existence for many years. Other metals, by and large, show similar patterns.

By themselves, studies of intensity of use are descriptive rather than diagnostic. It is therefore worth going behind the figures in more detail. One of the major statistical weaknesses of the worldwide minerals industry now arises. This is the lack of regular, accurate and comprehensive data on the ultimate end uses of the individual metals. Without such data it is difficult to track exactly how demand has moved in the past and how it might change in the future. Table 1 is based solely on some fairly rough and ready estimates for the United States.

Table 1

UNITED STATES' DOMESTIC CONSUMPTION OF METALS BY END USE 1979 & 1984
(percentages)

	Aluminium		Copper[a]		Iron & Steel		Lead		Nickel		Zinc	
	1979	1984	1979	1984	1979	1984	1979	1984	1979	1984	1979	1984
Building & construction	24	18	18	34	27	31	3	3	9	10	40	45
Electrical	11	9	58	24			2	2	13	11	12	9
Machinery & equipment			9	16	20	19			7	7	10	11
Transport	22	20	9	12	31	27	73	75	24	24	26	25
Consumer durables	8	8				7			7	8		
Packaging	23	35			6							
Other uses	12	10	6	14	16	16	22	20	40	40	12	10
Total Consumption '000 tonnes	5,341	5,330	2,433	2,100	121.6[b]	99.3[b]	1,259	1,030	205	204	929	1,030

Source: Mineral Commodity Summaries 1980 and 1985.
Note: blanks denote no information given and included in other uses.
[a] Definitions apparently altered between 1979 and 1984, with the electrical demand being re-allocated in 1984.
[b] million tonnes.

These are not entirely representative of the world as a whole, but they do bring out some important points. Demand for lead is dominated by the transport sector specifically for batteries and gasoline additives. Transport is also a major consumer of the other metals, except copper. Demand for aluminium is biased towards consumption, more so in the USA where packaging outlets are more important than elsewhere. Capital expenditure is the main determinant of demand for copper, iron and steel, and zinc, and probably of nickel were the allocation of end uses carried out properly. This dependence on investment and the transport sector provides a structural explanation of changes in demand for metals, an explanation that is more intellectually coherent than the sudden change in consumers' behaviour implied by many of the arguments about substitution and miniaturization.

The Behaviour of Investment

Here we enter another statistical minefield, in that few comprehensive historical data are regularly published on total capital expenditure, let alone forecasts. The main economic consulting firms often do not give figures for individual countries, let alone totals. It is clear that expenditure on investment has lagged behind consumer spending in the past decade, and that it has accounted for a diminishing portion of the OECD's total gross domestic product. Figure 1 compares the behaviour of real GDP and investment (gross fixed capital formation) in the OECD Area since 1970.

The latter's share of GDP dropped to 19.7 percent in 1983, the lowest overall share for at least twenty years. The fall was especially pronounced in the United States.

Going beyond the totals gives the picture shown in figure 2. Remember that building and construction figure prominently as major outlets for several metals.

Full details of 1984's spending are not yet available, except for residential construction. Expenditure on machinery and equipment, which includes vehicles of all types, is much higher now than in the early 1970s' boom. Much of this spending has been on cost cutting of all types and on enhancing productivity rather than on expanding capacity. In short, it has gone into equipment with high value added rather than into metals-intensive plant. The contrast with spending on construction, and especially on the nonresidential variety, is marked. These have clearly suffered from the slowdown of economic growth since the early 1970s.

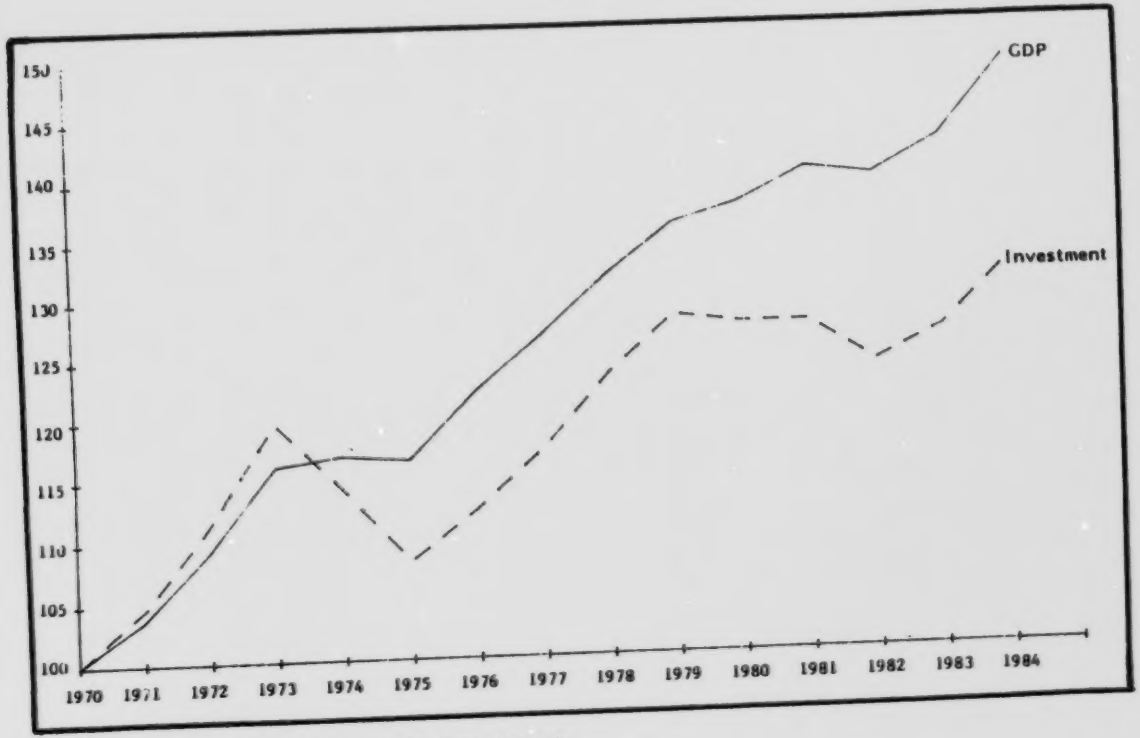

Figure 1. OECD Real GDP and Investment (index numbers 1970=100)

Source: OECD Historical Statistics 1960-83

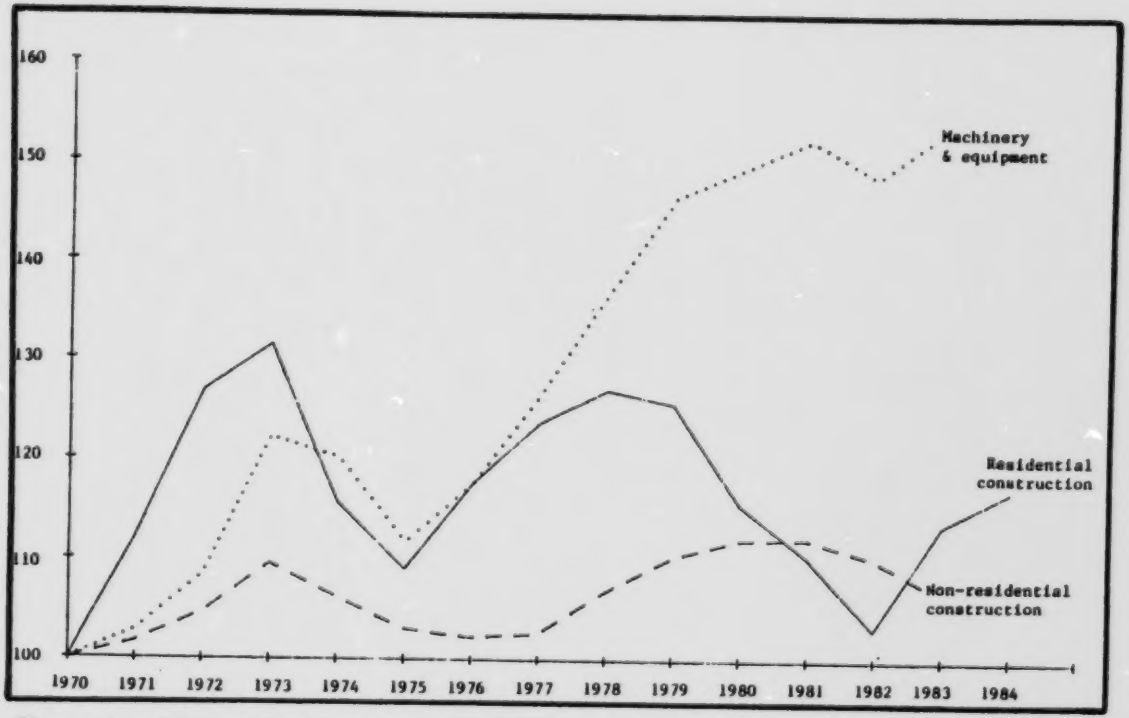

Figure 2. OECD Real Investment by Type of Asset (index numbers 1970=100)
Source: OECD Historical Statistics 1960-83

Over the 1960-83 period, nonresidential construction made up 36 percent and residential construction 25 percent of total OECD fixed investment.

Table 2 summarizes the slowdown in capital expenditure compared with total real GDP since the 1960s, and, for good measure, includes figures for industrial production and automobile output.

Table 2

OECD AREA GROWTH RATES 1960-83

	1960-68	1968-73	1973-79	1979-83
Gross domestic product	5.1	4.8	2.7	1.2
Industrial production	6.3	5.5	2.1	-0.4
Gross fixed capital formation	6.5	5.9	1.1	-0.3
of which:				
Residential construction	5.7	6.5	-0.8	-2.5
Nonresidential construction	6.5	3.9	0.1	-0.8
Machinery & equipment	7.3	7.6	3.0	1.2
Automobile Production	6.5	5.7	0.2	-1.0

Sources: OECD & IMF Statistics.

The addition of figures for 1984 would not materially alter the conclusions that can be drawn. A goodly part of the declining intensity of use of metals is closely related to the relatively poor performance of the sectors to which metals are sold. The question then arises as to whether these weak performances are irreversible. Logic, quite apart from the deteriorating state of the infrastructure on both sides of the Atlantic and Pacific, suggests that they are not. To some extent they are yet one more manifestation of the excess, or wrongly located, capacity engendered by a sudden and unpredicted change in the rate of economic growth, and by marked shifts in relative costs. The mineral industry's customers have been as affected by these factors as the industry itself.

Steps and Slopes

Strangely enough, its sectoral composition has not figured prominently in most explanations of recent trends in demand for metals. Instead, attention is concentrated on accelerated technological change; on the rapid spread of computer aided design in all its ramifications, and on the development of new materials and more precise manufacturing techniques. Intensity of use may have fallen in the past, runs the argument, but "you ain't seen nuttin yet" (to quote an ungrammatical utterance of the U.S. President). All is clearly not for the best in the best of all possible worlds, but is it really a Panglossian view of the future to suggest that such apocalyptic forecasts for the older metals are somewhat overdone? The burden of proof surely lies on those who make them, and they tend to forget that the effective diffusion of technical change is a much more protracted affair than the initial innovation. In short, substitution will lurch somewhat unpredictably, much as it has done in the past, rather than in leaps and bounds.

More ephemeral influences have also been at work on demand for metals in recent years. These are mainly linked with the re-emergence, albeit at historically high levels, of the norm of positive real interest rates in North America and the United Kingdom. Coupled with greatly reduced inflationary expectations, such rates have virtually eliminated speculative demands for metals, and have encouraged the liquidation of non-trade stocks. Consumer preferences have decisively switched from materials to financial assets. Genuine users have also pared their stocks to the bone, assisted in this regard by even more sophisticated computer-based techniques of inventory management. These reductions in inventories throughout the production and distribution chain are once-for-all steps. Now that they have occurred they should theoretically have no further influence on demand. That remains to be seen in practice. It is one thing to boast about just-in-time inventory policies when supplies are plentiful and prices weak, but quite another when there is no spare material available to keep the presses running even for ready money. Furthermore, an overall reduction of pipeline stocks reduces the timelags between changes in final demand and in requirements for raw materials, and increases the system's capacity for short-run surges in demand. The aluminium industry was caught by such a surge in 1983-84.

Excess Capacity

The inevitable counterpart of the slackened growth of demand for primary metal coinciding with long lead times for investment has been a general persistence of excess capacity. This was compounded by a general failure to recognize that the mining industry faced something more than a severe and prolonged cyclical downturn. The easiest route to cost cutting in order to sustain profitability in the late 1970s and very early 1980s was to expand, which further compounded the overall problems. The desires of raw material producing countries to upgrade their raw materials and of consuming countries to establish their own plants rather than rely on imports worsened the surplus at the processing stage. Figures 3 and 4 show the trends since 1972 in the amount of mine capacity in operation, and in its utilization for four base metals. Capacities, always fairly imprecise if only because of changing ore grades, have been calculated on a consistent basis throughout. Mines which remain shut for an entire year are not included in that year's capacity, and this gives an upward bias to the utilization rates in the later years. Figures 3 and 4 look at copper and nickel, and figures 5 and 6 at lead and zinc.

It should be remembered that 1972's utilization rates were depressed by a recession which may seem mild in retrospect, but which appeared fairly severe at the time. Each metal naturally has its own idiosyncracies. Nickel has occasionally been affected by lengthy strikes, and primary lead mines are partly governed by demand for silver and zinc and partly cushioned by varying production of secondary metal. Figures 3-6 demonstrate the persistence of excess capacity since the 1973-74 boom. This excess was worsened by increases in the capacity of all metals except primary lead. The relative stagnation of the latter helps explain the boom in lead prices during the late 1970s.

Lest these four base metals are regarded as special cases, table 3 looks at a much broader spread of 45 minerals. It contains approximate measures of the Western World's degree of capacity utilization in the mid 1980s. The figures are fairly rough and ready because they are based on 1984's mine production and the U.S. Bureau of Mines' projections of capacity in 1985. Not all the new mines included in the latter will have materialized, and some existing mines may have been closed. Furthermore, many of the mines included will seldom, if ever, produce at their maximum nominal throughputs. Even with these very important qualifications, the table does give a useful snapshot of the general extent of surplus capacity in the mining industry.

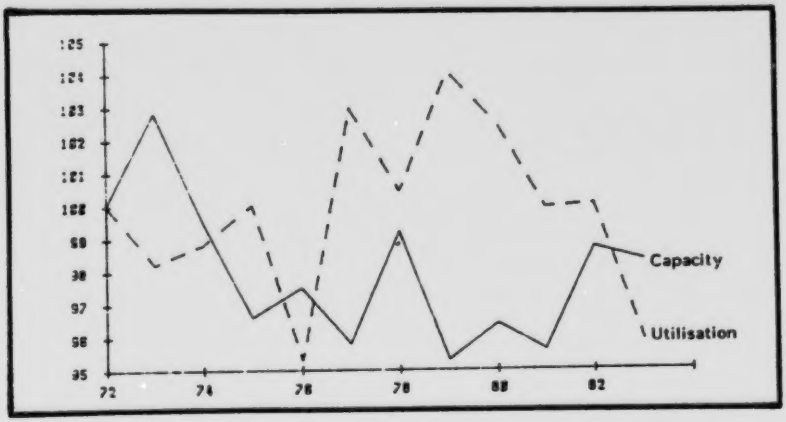

Figure 3. Mine Capacity and Utilization: Copper, 1972-83 (index numbers 1972=100)
Source: RTZ Mine Information Service

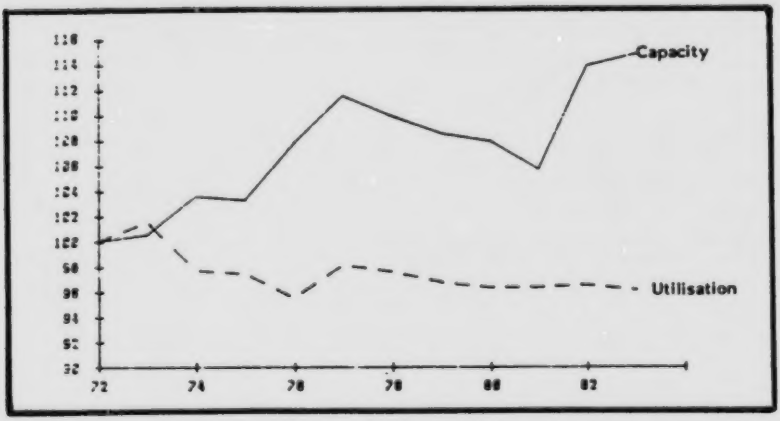

Figure 4. Mine Capacity and Utilization: Nickel, 1972-83 (index numbers 1972=100)
Source: RTZ Information Service

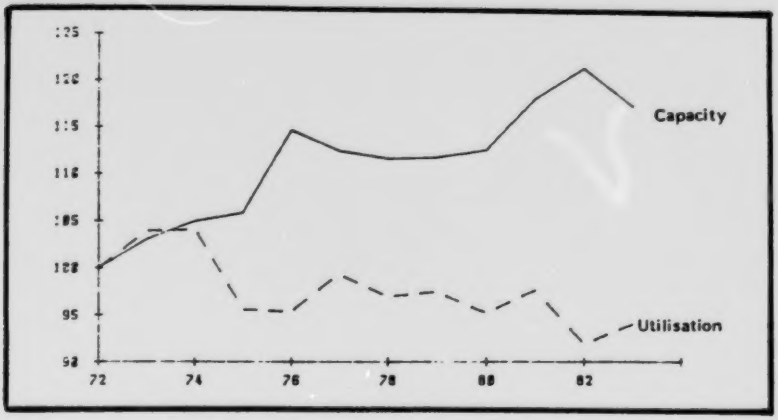

Figure 5. Mine Capacity and Utilization: Lead, 1972-83 (index numbers 1972=100)
Source: RTZ Mine Information Service

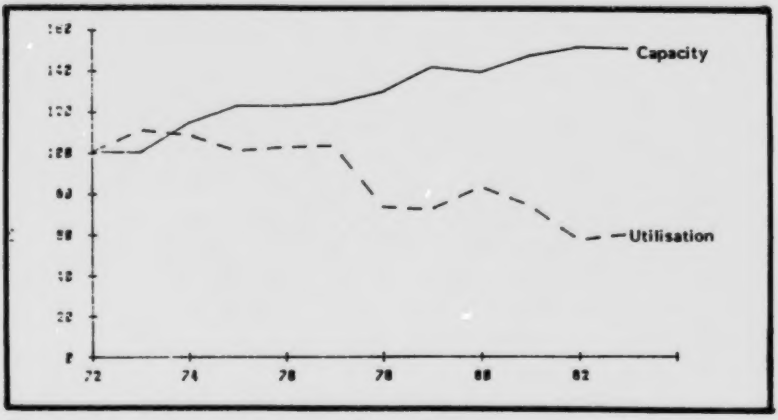

Figure 6. Mine Capacity and Utilization: Zinc, 1972-83 (index numbers 1972=100)
Source: RTZ Information Service

Table 3

WORLD CAPACITY UTILIZATION IN MINERALS: MID 1980s

Mineral		Capacity Utilization (percent)	Mineral		Capacity Utilization (percent)
Aluminium:	bauxite	56	Mercury		44
	alumina	64	Mica		47
	metal	63	Molybdenum		57
Antimony		59	Nickel		58
Arsenic		43	Niobium		47
Asbestos		60	Phosphate		79
Barytes		70	Platinum Group		77
Beryllium		27	Potash		76
Bismuth		58	Salt		73
Borates		60	Silver		82
Bromine		76	Strontium		86
Cadmium		58	Sulphur		67
Chromium		69	Tantalum		61
Cobalt		69	Thallium		68
Copper		68	Tin		70
Fluorine		65	Titanium:	ilmenite	62
Graphite		91		rutile	75
Gypsum		94	Tungsten		73
Iron Ore		54	Vanadium		46
Lead		72	Vermiculite		63
Lithium		57	Zinc		75
Magnesium		51	Zirconium		70
Manganese		66			

Sources: Capacity from Mineral Facts & Problems, 1980 Edition. USBM Circular 671.
Production from Mineral Commodity Summaries 1985. USBM.

Note: capacity utilization is shown as production in 1984 as % of estimated capacities in 1985. In most instances the percentages are based on mine output only.

Some Effects of Excess Capacity

Many of the mineral industries' present problems flow directly from the persistence of surplus productive capacity for so long. Whether or not that is a structural change is somewhat debatable, as it carries the seeds of its own elimination. In some minerals the restoration of supply and demand equilibrium is well advanced, whereas in others it started later and has much further to go.

The main effects of excess capacity have been twofold. First, the previous close link between prices and costs has been broken. This is best demonstrated by figure 7, which is by now probably fairly well known. It shows copper costs and prices annually since 1969.

Figure 7 compares average high and low LME copper prices with four points on the cumulative cost curve of copper mines for each year. The points are respectively 25 percent, 50 percent, 75 percent, and 90 percent along the curve of cumulative production. In previous years, when supply and demand were broadly balanced, prices tended to hover above the upper limit, which might loosely be defined as marginal costs, but in recent years they have dipped well down. The mining industry has responded with vigorous cost cutting programs, of both the "good", or permanent and of the "bad" or temporary variety. The mix between "good" and "bad" is an interesting question that will probably only be answered precisely with the passage of time. Either way, cost cutting has been insufficient to force the marginal costs of many minerals below prevailing market prices.

This is partly because of the second main effect of excess capacity: it has offered considerable scope for the expansion of spot and terminal markets of all forms. New entrants, and producers without forward linkages with customers, have resorted to traders and merchants to dispose of their output. These middlemen are more concerned with their margins than with the basic supply/demand balance. Also stocks have been amassed by producers, and merchants, some of whom may be constrained to sell by financial pressures. This rise in producers' stocks is a counterpart of the rundown of consumers' inventories already mentioned. Major producers have been unable to hold to cost-related list prices, and the consequences has been greater price volatility, and lower price levels relative to average costs.

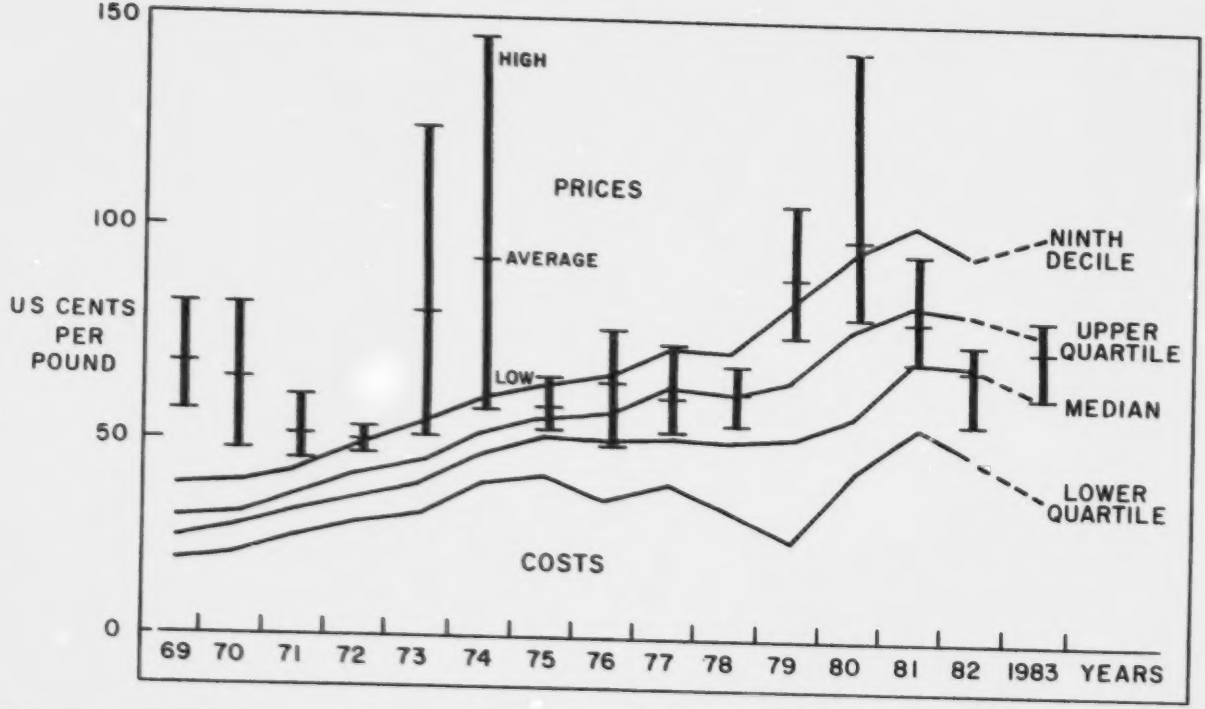

Figure 7. Cash Breakeven Costs and LME Prices of Copper, 1969-83 (U.S. cents per pound in money terms).

The Diffusion of Political and Economic Power

The weakened ability of major mineral producers to control their prices is one by-product of a genuine structural change over the past twenty years. This has been the diffusion of political and economic power away from North America and Western Europe. The rapid development of Japanese demand opened up sizeable new opportunities for Pacific Rim mineral producers in the 1960s and early 1970s, creating, for example, a market in copper concentrates. The more recent development of other South East Asian economies and of Latin America has further widened markets, incidentally increasing the scope for merchants.

More important, the decolonizations of the post war decades were followed by strong desires for economic independence to support political independence. Canadians do not need reminding that economic nationalism, particularly when concerned with resources, has not been confined to the developing countries. The wave of nationalizations of the late 1960s and early 1970s changed the mining industry's structure of ownership and weakened the hold of major international mining companies on world supply. Tax increases everywhere greatly lowered the mining companies' financial resilience in hard times. The successor companies, usually state owned or controlled, who have often made considerable contributions to additional capacity, have lacked marketing and financial expertise. Furthermore, they have perforce paid far more regard to national economic objectives than their predecessors. It is unclear whether the more recent temporary entry of the oil companies was, with apologies to Karl Marx, history repeating itself as tragedy or as farce. It probably depends on which side of the fence the spectator of that interesting episode in the mining industry's recent history was sitting. The oil companies have not been the only new entrants who have further spread the industry's ownership in recent years.

Much of the comment about the damaging effects of state ownership on the minerals industry has been marked by an almost complete absence of logical analysis. The main impact has been a diffusion of power and objectives on the producing side of the industry, and a further weakening of links between producers and the market.

Final Comments

The more usual complaint about state-controlled production is its inflexibility. That is merely one aspect of these

weakened links, and state-owned producers are by no means the only culprits. The conflict between the requirements of healthy mineral and metal markets on the one hand and the preservation of jobs and local incomes on the other is being fought throughout the world. All producing and consuming countries are in the long run best served by a healthy and efficient minerals industry whose worldwide supply and demand are in broad dynamic balance. Unfortunately, measures being taken in many countries, and not least in some Canadian provinces, are deferring the restoration of that balance. Where such measures are a response to genuinely temporary adverse factors, they may be justified. It is, however, better to act directly on the basic causes of imbalance, such as an over-valued currency, than on the symptoms, such as uncompetitive mines. Subsidies and temporary reductions in the prices of inputs merely transfer the mining sector's burdens to someone else. Herein lies the perennial dilemma of the mining industry; individual survival may be at the expense of prolonging the overall imbalance. Yet that imbalance is gradually being righted, and the survivors can look forward to a reasonably healthy old age.

CHANGING DEMAND PATTERNS:
Panel Discussion

William G. Deeks

Change is all around us. This is particularly so for the business of producing and selling metals and minerals for end-use markets. Historic change has always been viewed as cyclical change, and we are probably still in a cyclical pattern but the time frame from the beginning to the end of the cycle has been considerably extended. In addition to cyclical change, however, we are also seeing the effects of structural change. A definition for structural change is change taking place which is permanent and probably not reversible.

Examples of structural change include: competition from production in structured economies; the economic impact of changing currency values; the competitive thrust from new man-made materials; the impact of design changes, particularly for consumer durable products making the use of traditional materials obsolete, changing growth patterns in markets related to affluence and population growth; and changing consumer expenditure priorities. Collectively, all these changes are having a profound and negative impact on the economics of the mineral industry, especially in North America. Intensive competition has been created for markets, partly between producers in different economies with different currencies and partly between materials themselves.

Historic ideas of value are being challenged. What is the right price for a commodity today? Does it link to historical trends, or is it, in essence, facing a new set of realities in terms of value opposite substitute materials? Everywhere one looks, production costs have to be reduced in dollar-based economies in order to compete with lower wages and currency values from other countries. Are jobs in our society worth today what they were worth 10 years ago? What will happen to the level of wage rates in traditional U.S. and Canadian industrial centres compared to the willingness of people to work for much less in other countries and even the southern United States? Have some sectors of our industry been burdened with taxes and other costs related to working with government which are eroding their competitive ability? Are there environmental burdens placed on the production of metals and minerals in Canada and the United States which cannot be borne and, there-

fore, are the forerunner of a noncompetitive and closed down industry? These are all questions we have to focus on now.

Searching for answers is frustrating, as there do not seem to be many readily available ones. Obviously, one of the answers to the problems being faced by the mining and metallurgical industry is to put a great deal more effort into product research and market development. Along with this needed commitment, there is also the need for continuing effort in improving production systems in a push for much higher productivity and, finally, real emphasis on the need for impeccable product quality.

As well, new initiatives in the visibility and transparency of the industry are required. Noranda has been a strong advocate of the merits of study groups on an international basis to provide a forum where the problems and opportunities for a particular commodity can be reviewed by the major participants and their governments in the hope that more sensible business decisions will result. This should lead to an enhanced industry with a deep commitment for product research and market development, rather than a depressed industry with no funds to protect itself.

Overall, our belief is that, as never before, the industry must become market driven. By market driven, one means an industry that is concentrating on customers and what customers expect from it.

The GM Saturn program is a really good example of a major change taking place in the manufacture of a world-class competitive small sized automobile in the USA. Saturn will be seeking to cut the cost of making cars in North America in half, and will be striving to accomplish this through a high degree of automation, rigid inventory control, new assembly and component manufacturing systems, faultless performance of parts at all times, efficient use of materials, elimination of scrap, and employment of the kanban concept.

Kanban originates in Japan and is the practice of a Japanese housewife to indicate to her baker that she needs another loaf of bread by putting a small wooden disc in a wicker basket outside her door. This truly is "just-in-time delivery" of a needed product to do a specific job. The housewife's inventory control procedure is through the use of the wooden disc which triggers the delivery to provide the bread she needs to feed her family at that moment. Industrially, the kanban concept embodies statistical process control to assure a quality driven production system and just-in-time delivery to ensure direct shipment of components onto an assembly system without the need to hold wasteful inventories and all the double handling that goes with it.

Saturn and kanban are simply a reflection of the way things are heading, and if they are heading that way in the motor vehicle industry, eventually all manufacturing operations will be faced with the same need for productivity gains, modernization of processing facilities, better manufacturing assembly systems, computer controlled and organized flow of materials and very much higher-quality standards.

These concepts present some formidable challenges for Canadians. For many of our metal and mineral businesses, the Canadian market is too small to justify the kind of investment needed to provide the state-of-the-art facilities necessary to be competitive. The answer for Canada has to lie in much greater access to the U.S. market. It is only with that access that large segments of the Canadian manufacturing industry are going to be able to justify the capital needed to improve their facilities in order to be competitive.

The irony is that we really have no choice, because if we do not modernize and become competitive, Canadian manufacturers will slowly go out of business as their products are replaced with products made elsewhere, quite possibly in the Pacific. Already there are small manufacturing enterprises in Ontario shifting their production to the Pacific and using their Canadian operation as an assembler and distributor. It is time we focused on what is happening to these basic core manufacturing enterprises in the Canadian economy. We cannot afford to have our basic production systems move offshore. We cannot survive as a service country without the wealth creation that goes with an active and expanding mining and metallurgical industry on the one hand and a manufacturing and processing industry on the other.

Part of the hurdle we have to cross in facing the competitive reality of the future is the use of computers in the management of our business. Modern state-of-the-art manufacturing and assembly processes are heavily linked to computer systems. Computers monitor the performance of equipment, providing exactly the right characteristics to produce a predictable high-quality part. Other computer-driven machines finish and prepare parts for final assembly. Even more sophisticated machines have the ability to sight, through laser technology, the different configurations coming down an assembly line and then to program the action at each station automatically, exactly conforming to the particular component approaching.

The guesswork is being taken out of the production process. Manufacture proceeds on the basis of known data

and predictable machine action. No longer is it feasible for one man to operate one machine. Now it is more likely that one man will operate ten machines, and work from a computer console.

The hurdle of moving into electronic management is both a knowledge and a culture shock, and it cannot be done by chance or happenstance. Introduction of electronic management systems into an enterprise must be carefully planned, with good orientation and training programs for the people involved. It is absolutely essential that it have support from owners and senior managers in order that the people involved realize the fundamental commitment of the enterprise to change which is necessary. A major focus on manufacturing in Canada with this perspective is required today.

To summarize, there is no question that we are being buffeted by the forces of change today. Answers to our problems lie in increased and serious commitment to research and development at both the processing and the marketing stages of our industry. Access to the U.S. market is vital to expand our market base in order to justify the capital needed to upgrade our facilities. Competition is severe and will continue to be so, in many cases arising in structured economies with premium domestic markets protected from imports and juicy incentives for exports. It is absolutely necessary that Canadians understand the competitive trade environment in which we are competing, so that appropriate actions can be taken in Canada to counter the destructive impact of such subsidized activity.

CHANGING DEMAND PATTERNS:
Panel discussion

George A. Jewett

The essence of structural change today is that competition is forcing industry to achieve major improvements in productivity, product quality, and performance. Industrial society experiences change of this magnitude only when technology offers the possibility of significant increases in efficiency, such as those offered by steam power and Henry Ford's production lines. Materials technology is the moving force this time. The momentum of such structural change is a flood tide, which benefits us all, if we can learn to swim.

This time, major technological developments in biology, information processing, and production technology are happening concurrently. All will have dramatic effects on society, for the better. Materials technology is almost certainly the most significant science of our age. In its own right, it makes cheaper, more reliable and higher performance possible. In addition, new materials developed by materials scientists make the advances of the other technologies possible.

Remember - the only reason Leonardo da Vinci designs did not "fly" was lack of appropriate materials. Science is now able to respond with materials to meet the needs of any innovator today. New competitors with new rules are attacking metal markets with innovative products developed in their research labs.

A common objective in industry today is higher quality, but at the same price. To compete, suppliers must improve quality and meet the market's demands or else they will witness diminishing sales. Quality can be improved either by increasing specifications, or by achieving more consistent performance by narrowing tolerances. There is another way: by ensuring that the user is taking full advantage of the properties of metals in his design and manufacturing.

Most manufacturing in metal in North America is based on outdated technology and substandard quality control, and as a consequence, overdesign is common. The result is loss of competitive advantage. The copper radiator is a case of a market that need not have been lost, because a competitor introduced new manufacturing technology, and better quality control. If the copper industry had been

there first (and it could have been) a 50,000-ton market could have been preserved. Of course such activity goes beyond the industry's traditional view of "selling".

The Oxford English Dictionary defines the verb to sell as follows:

- to dispose of in exchange for money;
- to keep stock of for sale;
- to be a dealer in;
- to prostitute for money or other consideration;
- to make a matter of corrupt bargaining;
- to find purchasers.

The plastics industry uses the last concept; the metal industry, the first three, although there are some who suggest that numbers four and five have been widely practiced in the metal trade in recent years. Polymers have achieved their greatest market penetration in replacing metals, and this trend is projected to continue for at least ten years. The loss in metal markets could exceed one million tons in aggregate over this period.

Polmer producers have expanded their markets by first analyzing the market opportunities carefully and correctly. They did this ten years ago. They then produced products to meet specific market requirements. Next, they developed efficient and cost-effective production processes for the user, and gave them to him. Engineering plastics commonly replace metals on a one-to-one basis, by volume, and commonly achieve weight savings of 50 percent - often because of overdesign in metals, and inefficient manufacturing metal technology.

The success of engineering polymers in replacing metals can be attributed to a variety of factors. Among the most important are cost savings and weight savings. While the raw material cost of even the most inexpensive engineering polymers exceeds that of metals, the plastic materials offer economies in processing and fabrication. Engineering polymers may be injection molded with significantly lower energy consumption and at faster production rates than die casting, the similar processing technique for metals. Many plastic moldings require no post-mold finishing, while metal castings and stampings must often be polished, deburred and cleaned.

Engineering polymers are particularly adaptable to production of multifunctional, single-piece assemblies. For example, an injection-molded business-machine housing generally includes such features as mounting bosses, through holes, integral color, and functional indentations,

which are incorporated during the molding cycle. With sheet steel housings, the cabinet must be formed and painted, fasteners attached and through holes cut or punched in separate operations.

Over the last 10 years, the plastics industry has organized effectively to create markets for their products, in spite of inferior specifications and market resistance. If the metals industry is to maintain market share it must do the same; it must learn to "sell" its product against plastics and other competing materials. The metals industry must focus on the marketplace, must be positive and look forward instead of backwards (which is what we do when we look at traditional demand patterns). The industry must learn again how to create demand.

Post World War II was an exceptional period in history, a period of exceptional demand when, in the words of Peters and Waterman, "anyone could make money". No one likes to be diminished in quite that way, but what if it is true? What if the period can be shown to be an historical aberration, and that there have been only two other comparable periods of inflation, escalating demand, and general increase in expectations in all commodity markets, especially metals? If that is true then we can anticipate years of stable commodity prices - in a very competitive market.

A CRS seminar earlier this year concluded that "metal markets are extremely cyclical". Let us get the tense right - they "were" but are not now, and almost certainly will not be in the future. We can identify oversupply scenarios in virtually every metal forward for at least ten years. In addition there is a new factor in the equation - substitution. Substitution is an ever-present threat today with stable, depressed prices. If the price of any metal should escalate rapidly today, the market will switch to alternative materials within a matter of months, or weeks. In most cases the switch will be irreversible for many years, if ever. For this reason there will be a powerful counterpoise to demand pull in this marketplace for metals, which will tend to keep prices stable for many years. Consequently, we can look forward to fluctuating demand, perhaps, but stable prices.

This is not all bad - it certainly clears the mind and may even provide the basis for some sound long term strategic selling strategies within the metals industry.

CHANGING DEMAND PATTERNS:
Panel Discussion

Gordon R. Peeling and Winston Chambers

Change breeds apprehension. Apprehension affects expectations, and expectations influence the behaviour of industry, labour and government. Thus, any change which is perceived as a threat to the established economic, social and/or political order is usually destabilizing and, in consequence, costly.

Structural change, i.e. fundamental shifts in the relative importance of the principal sectors of the economy, is of that kind. It is a source of serious concern because of its possible adverse consequences. It could, and indeed it has, resulted in:

- heavy financial losses and even the demise of companies;
- considerable unemployment through the obsolescence of skills or through dramatic changes in the capital-labour ratios of new production systems.

But structural change is not all bad. Despite its adverse effects, it it necessary for economic growth and development, and as a growth factor it invariably affords opportunities. In a sense, structural change represents a kind of paradox. On the one hand, it creates many difficult economic problems; on the other hand, it offers novel opportunities for industrial development and expansion. In this paradox lies the formidable challenge of how best to exploit the opportunities afforded by structural change while minimizing the private and social costs of warranted structural adjustments.

This is the critical problem which industry, labour and government must address. It is not an easy problem. It cannot be resolved overnight, and the way in which it is resolved will be crucial for the future commercial viability of the industry as well as the industry's contribution to the Canadian economy. Thus the development of appropriate structural adjustment policies becomes all important. But what, one may ask, are appropriate adjustment policies?

This is a singularly important question for which there can be no absolute answer. This is so because the answer entails normative considerations: i.e. subjective consider-

ations of what ought to be. Not surprisingly, therefore, there are likely to be widely different perceptions of what, in a given situation, constitutes appropriate adjustment policies. None the less, the formulation of structural adjustment policies, however perceived, demands a good understanding of:

- the determinants or sources of the structural transformation we are now experiencing;
- the magnitude, extent and impact of the changes;
- the nature of the threats they pose;
- the opportunities they present;
- the options that are open to the mineral industry; options which must be considered with reference to certain constraints. Some of these constraints are the openness of the mineral sector, the market structure of the industry, (e.g. absence of monopoly power) and the mineral development and trade policies of competitors and trading partners.

Determinants or Sources of Change

Broadly speaking, structural change is the consequence of the interaction of a complex set of factors. It may be brought about by underlying trends in productivity, technological innovation, demand patterns, or trade flows.

Structural change in the mineral industry can be attributed mainly to four factors. These factors are:

- economic forces;
- scientific and technological imperatives;
- government policies and regulations;
- international institutional activities and arrangements (e.g. concessionary financing of mine development by international financial institutions).

These four factors - economic, scientific and technological, government, and international institutions - are not mutually exclusive. Their activities interact to effect far-reaching changes in both patterns of supply and demand for minerals.

Economic Forces

The increase in energy costs, occasioned by a series of oil price shocks and the attendant energy conservation drive,

greatly affected the volume and composition of mineral consumption, as well as the processing technology of energy intensive minerals.

The imperative of reducing energy consumption, or rather of reducing energy costs in industrial production, prompted design changes in the automobile, aerospace and other major fuel-consuming industries. Design changes emphasized weight reduction and improved energy efficiencies. This led to substitution among metals. It also increased the demand for plastics, composites and modern ceramics as replacements for metals in several design applications.

In a period of escalating energy costs, the use of a new class of plastic-based materials - called the composites - has much to commend it. Composites can be stronger then steel, lighter than aluminum, and more rigid than titanium. Graphite/epoxy composite has the same strength and rigidity of aluminum, but is about 40 percent lighter. These properties of the composite are clearly economically and technically desirable in designing for performance and fuel efficiency. This explains why major commercial jetliners like the Boeing 767 and 757, Douglas DC-10s, and Lockheed L1011s all use carbon/graphite composites in several secondary structures to eliminate upwards of 1200 pounds of structural weight.

Aside from energy costs, the necessity of having to remain highly cost-competitive has been a source of structural change. In periods of low economic growth rates, stagflation, or major cyclical contractions in economic activity, new technology may be introduced to reduce the unit cost of production. The introduction of robotics in mining, and the emergence of mini-steel mills are cases in point. They represent significant structural changes on the supply side.

Scientific and Technological Imperatives

Certain scientific advances and technological developments create a demand for new materials. These new materials are critical requirements for the development and operation of the new technology. This kind of material requirement is evidenced in aerospace, rocketry, information-communication networks, and in the use of lasers.

The aerospace industry's need for materials with high strength-to-weight ratios and improved thermal shock, dielectric, abrasive, and refractory properties initiated a considerable amount of research and development in cera-

mics during the last decade. Among the advanced ceramic materials which was produced during this period was silicon carbide. One of the hardest substances known to man, it is used extensively in the manufacture of rocket nozzles. Currently, it is also being used for critical-wear components for pumps, valves, compressors and other equipment used in energy and chemical process industries to control flows of gases, liquids and slurries.

This use as a critical-wear component makes silicon carbide a substitute for some metals. Similarly, new concepts in communications, such as the use of satellites, microwaves, and optical fibre, have threatened to displace copper in communications.

Government Policies

Government, through various policy initiatives, contributes to structural change. Defence, environmental protection, resource procurement, and trade and development policies all can, and do at times, induce structural change.

Much of the development in materials technology in the U.S. is defence related. Graphite epoxy composites are now extensively used in fighter aircraft; and a major development in the use of composites in helicopter airframes is now under way. The U.S. Army sponsors the Advanced Composite Airframe Program (ACAP) which is attempting to produce the technology needed for designing and manufacturing new helicopters with all-composite airframes.

NASA is another strong supporter of composites, as is evidenced by the use of 4000 pounds of the material on the shuttle orbiters. The 60-by-15-foot bay doors of the Columbia are made entirely of graphite composite, making the craft 2700 pounds lighter than if it were composed entirely of aluminum structures.

Governments, through their regulatory initiatives, can also restrict the use of certain materials for a variety of reasons. The impact of environmental pollution and health protection regulations on the use of lead and asbestos is now well known.

The resource procurement strategies of resource deficient industrialized economies can also effect structural changes on the supply side. Where resource deficient economies endeavour to diversify their sources of supply both to minimize supply disruptions and to improve their bargaining leverage, such policies sometimes lead to major supply/demand imbalances demanding structural adjustment on the supply side. Indeed, a major problem facing many

mineral commodities today is the existence of surplus production capacity.

These examples of structural change are disturbing. For some observers, they portend a sunset industry. For others, they present difficult problems and challenging opportunities. How damaging has structural change been for the industry? How much of a threat does it pose for the future commercial viability of the industry as a whole, or major segments thereof?

These are, for the most part, empirical questions. To answer them adequately we must resort to facts and figures. There is, however, a paucity of relevant data. The reasons for this lack of data are two-fold. Firstly, the structural transformation is still in progress. Secondly, the industry is still being adversely affected by the lagged impact of the last global economic recession.

Nature and Extent of Structural Change

The fact that the industry has been affected simultaneously by a structural transformation and a major cyclical contraction compounds the difficulty of specifying the magnitude of the impact of structural change per se upon the industry.

Notwithstanding all this, there is some telling evidence of structural change. The lead industry provides a good example. Historically, lead has two major end-uses. The first of these was the lead-acid battery, which accounted for over 60 percent of total annual lead consumption. The second important end-use was as an additive to gasoline. Automobile emission control requirements and the development of new battery systems have seriously eroded the rate of growth of lead consumption. To counter the declining demand for lead in traditional uses, lead chemicals have been developed for stabilizing asphalt against cracking. Roadways paved with this new asphalt are being tested in the USA.

This is all very interesting. But a knowledge of changing patterns of production and consumption of a commodity or set of commodities does not in itself provide a sound basis for examining the nature, extent and impact of structural change. To know where the industry as a whole stands, how it is adjusting, and how it should be adjusting to change, it is useful to examine structural change with reference to two things:

- intrasectoral shifts, or endogenous changes;
- intersectoral shifts, or exogenous changes.

Although these two categories of structural change are not mutually exclusive, their identification is analytically highly desirable.

It is not fully realized, for instance, that there are major intrasectoral shifts from metallic minerals to non-metallic mineral materials. Examples of this are found in the substitution of composites for aluminum, titanium and steel; ceramic magnets and electrical conductors for conventional alloys; and optical fibres for copper. A tremendous amount of research and development has been under way during the last decade in the field of ceramics. Ceramic materials, which include ceramic fuel elements, piezoelectric materials, glass ceramics, magnetic ceramics, nonlinear dielectric ceramics, cermets, dry-film lubricants, special glasses, ceramic composites and refractory ceramics, are all derivatives of industrial minerals.

Ceramic development is reaching realistic commercial stages, particularly in Japan which is leading the way. They have established government-coordinated industrial initiatives involving over 200 private companies to work toward such long-term objectives as the development of fully ceramic engines. These programs also contain many shorter-term objectives to produce such ceramic products as auto parts, knives, scissors, etc. These shorter-term objectives keep the R&D relevant to consumer needs. They also provide revenue from sales to pay for R&D, while creating consumer awareness of the actual and potential use of ceramics.

The Japanese approach differs markedly from those of the USA and U.K., which are largely defence driven. The advantages of low friction, high wear resistance, and high temperature resistance make ceramics a desirable material for high temperature engines, such as fighter aircraft and tanks.

Challenges & Response

How have these forces for change affected the demand for and supply of minerals and metals generally? What problems do they pose, and what's involved in responding appropriately?

Broadly speaking, structural change and an accompanying cyclical economic contraction have led to a marked decline in the rates of growth of mineral production and mineral consumption. This reduction in the rate of growth of mineral consumption has given rise to excess supply, under-utilized production capacity, intense competition for markets, depressed mineral commodity prices, shrunken

profit margins, capital losses and resurgence of protectionism.

These phenomena have posed and continue to pose a major challenge to the Canadian mineral industry. Simply stated, the challenge is how to gain access to and maintain an optimum share of emerging markets for minerals and mineral markets.

In addressing the topic "Response to Structural Change", the 1985 Mineral Outlook Conference advanced some policy presciptions. The Conference held that if the Canadian mineral industry is to effect appropriate structural adjustments then the industry should strive to:

- reduce the cost of production by improving technology and productivity;
- eliminate waste, emphasize quality, and develop measures that focus on long-range goals rather than short-term return on investment measures;
- listen to the market;
- support and direct product development and market-oriented applied research;
- continue exploring new ore bodies;
- develop commodity study groups to improve market transparency.

These are necessary conditions that must be met to be competitive, but they tell us nothing about the market itself.

An essential precondition for gaining market access and maintaining an optimum market share under changing conditions is to identify the market or markets in which we must compete. This requires us to ascertain:

- how the industrial structures of our major trading partners have changed and are still changing;
- how these changes have altered and are still altering traditional patterns of mineral materials demand. (This is, no doubt, what is involved in the expression "listening to the market".)

Once the emerging material requirements of our major trading partners are identified, then the structure of our mineral industry should be examined, to determine what changes, if any, are expedient if the industry is to respond profitably to the changing material requirements of a world economy in transition. This could be a rewarding exercise. It would indicate desirable structural developments; it would provide a framework for evaluating the efficacy of traditional mineral commodity arrangements; and it could influence intra-sectoral investment flows.

FUTURE SUPPLIES OF METALS: THE TRANSITION

Simon Hunt and Graham Haclin

Economic Cycles to the 1990s

Seeing so much turmoil in so many producing countries that are substantial suppliers of metals, we were tempted to entitle this paper "The Renaissance of Mining in Developed Countries". But in discussing the concept, we decided that, while it is possible to reach that conclusion, it is premature. Premature partly because such a reversal in the pattern of world mineral supplies would require, among other things, the full recognition of the cyclical nature of the mining industry by the host government, such as Canada, in devising a tax structure which recognized this fundamental of mining. But more of that later.

Today I would like to leave two main thoughts with you. Firstly, that the metals industry is in a transition period, adjusting from endemic surplus to healthy growth and profitability. Adjustments, however, whether structural or evolutionary, present challenges and opportunities; and mining is no exception.

Secondly, the mining industry needs to protect, nurture and develop its end use markets as a matter of urgent priority. Failure to do so, or to do so using the cabbage patch philosophy without regard to the overall benefit to the industry, will prevent this transition from being accomplished. Mines need markets just as markets need mines.

Mining is a microcosm of the world at large. When long-term capital investment falls, as in the last decade, intensity of use for many metals declines; and vice versa. Looking at future supplies in isolation is as much good as looking at a bull elephant at ten yards through a pair of binoculars: the result would reproduce only the painful experience of the last decade. Demand and supply are interdependent. So before discussing with you the patterns of supply, which we see developing, I would like to share with you briefly our views of the economic cycles which we see shaping the world to the mid 1990s. I do so not only because what happens at the macro-economic level will directly affect demand, but because these cycles will affect supplies and management philosophy towards investment or, indeed, disinvestment. Recent experience is nearly always a powerful influence on the formulation of corporate policy.

We expect that the next ten years will see three recovery periods and two recessions. The striking feature of the recovery in the United States so far has been the growing mountain of debt at all levels, mirrored by the explosion of credit. For instance, for 1984 as a whole, nominal gross national product in the USA grew by $360 billion, but total domestic indebtedness increased by $715 billion. Thus each dollar added to GNP required two dollars of additional debt, a ratio which soared to 3:1 in the fourth quarter.

The distinguishing characteristic of the U.S. recovery is that debt is outpacing everything else: GNP, money supply and income. To find anything comparable in peace time, we must go back to 1929 when the debt-to-GNP ratio was a little over 2:1.

Such an excessive increase in money and credit should create inflationary pressures. Yet on the surface, none is apparent, as supported by the evidence of the GNP deflator, oil and commodity prices. Yet beneath these broad aggregate numbers there are some disturbing signals. In effect, inflation is being pulled upwards by the credit expansion in those sectors of the economy that are sheltered from imports, such as government purchases of defence and nondefence goods, the services sector, and residential fixed investments. Conversely, inflation is being pulled down by the dollar's strength, with import penetration preventing U.S. manufacturers from raising prices.

But the important point is that:

> borrowing creates an inflationary excess of purchasing power whenever the lender believes that he has not lost control of the purchasing power he has lent out until the borrower pays him back, but can sell or pledge the borrower's note whenever he wants to do a little more spending himself,

as Ashley Bladen wrote recently.

Looking solely at price indices as an indicator of inflation in the USA may well be misleading, as Keynes admitted after the hyper-inflation in Germany:

> Anyone who looked only at the index of prices would see no reason to suspect any material degree of inflation; whilst anyone who looked only at the total volume of bank credit and the prices of common stocks would have been convinced of the presence of an inflation actual or

impending. For my part I took the view at the time that there was no inflation. Looking back, I believe that a genuine inflation developed some time between the end of 1927 and the summer of 1929.

Today the Federal Reserve is in a box that is tightening continuously. Policy formulation has to be directed towards maintaining, or at least trying to maintain, economic growth and preventing the insolvency of a number of institutions. At the same time the Federal Reserve does not want to reignite inflationary fears. Yet it is unable to lean against these fears aggressively because an increase in the cost of money would have dire consequences on the attitude of Third World debtors. Indeed there are ominious signs that a deterioration will occur in the coming months as these debtor nations are finding the social strains of continued austerity to be unacceptable.

It is against this background that we path our pattern of economic development to the mid 1990s. Timing is given as a guide to direction only, and not as a "given". If it were so, I would have no need to be here today!

Recovery Phase I. This will continue until June/July 1986 in the USA and end 1986 elsewhere. Late this year and in early 1986 economic growth will be surprisingly strong in the USA. Shoring up the Farm Credit System will require a large dose of fiscal and monetary stimulus, starting sometime in October. By year end a rising budget deficit and open monetization by the Federal Reserve will be evident. The dollar will fall, having first continued its recovery; base and precious metal prices will rise; and market perceptions and asset structuring will shift from a disinflationary environment towards inflation hedging.

In the second quarter of 1986 the Federal Reserve will be forced to lean heavily against these pressures. Base and precious metal prices should peak in Autumn 1986.

Recession I starts in the USA in August/September 1986 and the rest of Western World between December 1986 and March 1987. This recession may not be so severe as we earlier thought; the more prolonged recovery, higher inflation in 1986, and more patch work on LDC debt could further postpone the inevitable financial debacle.

Precious and base metal prices should reach their low point in July/August 1987.

Recovery 2 starts in the USA around October/November 1987 and elsewhere by spring 1988. This period is likely to be characterized by more severe inflation, by strong economic growth with base and precious metal prices

peaking in first quarter 1990 at levels beyond what we can contemplate today. For instance, one of my technical friends, who has been following these markets for as long as I am old, has a clear pattern of gold prices; each peak is six times the previous cycle's low price. Thus he maintains that $285/oz was the low to give a gold price in the first quarter of 1990 of $1710/oz! It is around this period that the financial system could come under its greatest strain.

Recession 2 starts soon after in Spring 1990, is deep, severe with a basic reform of the international monetary system a likely prospect. As a result, interest rates will plummet, inflation will be contained, and long-term borrowing costs will revert to the long-run average of around 2 percent in real terms.

Recovery 3 will start towards the end of 1991, resulting in durable growth characterized by capital investment, particularly in infrastructure, electrical generating and distributing capacity, and energy, reminiscent of the 1960s.

Such is a thumbnail sketch of what we see ahead. Against this background, I now turn to the changing supply and cost patterns of the industry, and to tax reforms, which are necessary in many developed countries.

Highlights of Host-Country Influences

Although as yet uncertain, there is evidence to suggest that during the next decade we may see a renaissance of the mining industry in the industrial world. Much will depend on the attitude of host governments, as I have suggested earlier, and will discuss later.

How can we suggest that mining in the industrial countries is undergoing recovery when all the evidence, for the past decade, suggests that the reverse is true? In developing countries, continued and more rapid devaluations, creating increased social tensions, rising inflation, shortages of capital and foreign exchange combined with declining ore reserves in a number of countries could bring this about. So let us look at a few countries briefly.

Zambia. Production decline is accelerating. The percentage of foreign exchange revenue now being returned to the mining industry has fallen to 19 percent, compared with ZCCM's stated minimum requirement of 42 percent. State mining tax, effectively a front-end royalty on production, has been doubled recently from 10 percent to 20 percent, putting a further squeeze on the hard-pressed copper industry. Morale at all levels is low. By the mid-1990s capacity will be below 400,000 tonnes.

Zaire. While Zaire has not recently been in the news, nevertheless the situation will always remain uncertain. Any disruption of its rail system to the South African port of East London would be disasterous because of the deterioration in the "national route" to Matadi.

Philippines. Despite the reactivation of Sipalay, based on Japanese finance, 9 mines remain closed in the Philippines, all having ceased production since 1981, representing a loss in copper capacity of some 45,000 t/a. Furthermore the two major producers, Atlas and Philex, are in trouble due to serious maintenance and operating problems brought about by the adoption of short-term expendiency measures, inadequate planning, insufficient investment and serious foreign exchange shortages. Couple this with the increasing political tension in the country, the future of the Filipino mining industry must now be questioned. Capacity will fall below 200,000 tonnes by the mid 1990s.

Peru. The well publicized political and financial problems of the country will make it difficult for the government or the mining industry to attract capital. Capacity is likely to remain at around current levels of 370,000 tonnes.

South Africa. The current difficulties facing the country include political problems arising from polarization of power and a government whose policies are not condoned by the outside world, as well as a large build-up of short-term debts.

Chile. The example of South Africa should not go unheeded for Chile. While copper production is never likely to be disrupted for long, political difficulties could surface over the next ten years, making investment there even more difficult. Nonetheless, unique projects, such as Escondida, will always eventually attract investment, probably with greater assistance from the international financial institutions.

The foregoing examples illustrate a fundamental change in the future supply pattern for certain metals. The timing element plus a combination of other factors point to future capacity limitations and a marked improvement in the balance between mine capacity and likely demand. By the early 1990s, and for intermittent periods before then, there is growing evidence to suggest that mine capacity utilization will be at a high level for some metals even assuming only modest growths in consumption. This appears to be true for copper and zinc, and, because of the decline in South African output, also gold.

The factors contributing to this change are:

i closures that have already taken place, coupled with the difficulties of reactivation with only modest gains in metal prices;

ii the over mining and high grading which have been forced on the industry due to weak metal prices, which will result in future grade declines, lower output and shortened economic lives for major mines;

iii the maturity of many mines, reflected in limited finite reserves, limited scope for incremental expansions, rising cost structure, and falling production;

iv price constraints, capital constraints, greater selectivity and a generally more conservative approach have led to delays and deferments of many new projects. The result has been a period when few new projects are coming on stream. This situation will continue for a further few years, and is in sharp contrast to the rapid expansion in capacity which took place in the 1960s and early 1970s which produced the severe supply-demand imbalance that has plagued the industry for almost a decade.

Let us examine, in a little more detail, some of the changes which are currently taking place and which will have a significant impact in the 1990s. In particular let us look at reserves, the maturity of many major mines, and mine closures.

Declining Ore Reserves

Paradoxically, while total world reserves of known mineral deposits have been rising rapidly, total world reserves of ore have declined. We must all remember that "ore" is an economic concept. Put simplisticly, it is "mineral which can be mined and processed profitably". Thus, ore reserves are as much dependent on future metal price projections, capital investment, interest rates etc., as they are on the undoubted skills of the exploration geologist.

In the past five years, we have witnessed a rapid decline in the ore reserve base of many existing producers. This is attributed to the following reasons.

The Necessity to "High Grade" or "Over Mine"

This has been a legitimate and natural response to lower metal prices necessitating survival economics, namely "mining for cash". Nevertheless, a price has to be paid, either in the form of sharply reduced mine life, or the need for substantial capital injection. Typically, higher grade ores have been mined, thus appreciably lowering the remaining ore reserve grade, while long-term development has been kept to a minimum. The combination of sharply lower future grade trends and the need for substantial capital investment will inevitably jeopardize the future viability of the operation, in the absence of a substantial and sustained metal price improvement.

The Necessity to Reappraise Mining Schedules and to Raise Cut-Off Grades and/or to Reduce Stripping Ratios

Clearly, as economics change, mining operators have to reappraise their situation. Often this is a slow process. Mine closures can be categorized into two groups: first, those in which "ore reserves are depleted" and, secondly, those which have closed "due to low metal prices". Clearly, in both cases ore reserves by definition have been depleted. It has been suggested that reactivations of closed properties will inhibit metal price improvements. Although potential reactivations could have a modifying influence on metal prices in general, these mines need appreciably higher metal prices to justify the heavy capital investment necessary to bring them back on stream.

Maturing Mines

Mines, like humans, experience three phases during their life cycles; youth, middle age and maturity (not, I would add, to be confused with old age, which none of us experience!).

The youthful phase is characterized by expanding ore reserves and expanding production. A series of incremental expansions typically takes place, but the ore reserve base also increases despite rising output. In the middle phase, it becomes increasingly difficult to expand the ore reserve base. Furthermore, incremental expansion becomes necessary.

Nevertheless, most mining companies now accept that the future health of the metals industry depends on compet-

itive prices to ensure market growth. This lower price scenario must inevitably affect ore reserve calculations, leading to higher cut-off grades, lower stripping ratios, and modified mining schedules. We have recently witnessed a significant downward readjustment of ore reserves by many mining companies.

Mine Closure and Possible Reactivation

While uneconomic mines are not, by definition, mining ore, it is common to continue to refer to their mineral reserves as "ore reserves". However, once these operations have ceased production, it is reasonable to question whether the operation will be reactivated and consequently whether or not the mineral deposit should retain the status of an ore-body simply to compensate for declining ore grades. Finally, the mature mine is characterized by limited life, declining ore grades, and a whole list of adverse cost factors: e.g. deeper mining, extended haul distances, ventilation and pumping problems, temperature gradients, greater rock hardness and so on. In addition to cost pressures, declining ore reserves limit the scope for incremental expansion, thereby removing one means by which costs can be contained.

In both copper and zinc, the past five years have witnessed an unprecedented level of mine closures, particularly in North America. Taking copper as the example, some 920,000 tonnes of copper mine production has been closed in the past five years, based on production figures for 1980-81, as shown in table 1.

Table 1

COPPER

Country	Lost Production Capacity (t Cu in conc.)
USA	637,300
Canada	103,600
Philippines	39,000
Australia	25,000
Other	115,200
Total	920,600

As already outlined, high grading, over mining, limited stripping, reducing capital expenditure are all contributing to reduced mine life. Many of the world's major mines, developed in the 1950s and 1960s, will be reaching the end of their economic lives in the 1990s.

Again, taking copper as an example, the projected lost capacity, based on actual 1984/85 production rates, is shown to the year 2000. It amounts to a staggering 1.277 million tonnes, as shown in table 2.

Table 2

PROJECTED CLOSURES (1986-2000)

Country	Lost Production Capacity (t Cu in conc.)
USA	1,310,600
Canada	178,400
Philippines	202,000
Australia	45,000
Other	541,300
Total	1,277,300

These factors are illustrated vividly in the illustrations of future capacity for copper and gold. Although our detailed projections may be inaccurate in detail because we have used conservative assumptions, the trends they show must be taken seriously. Statistics, however, are like a bikini. What they reveal is suggestive but what they conceal is vital. The statistics given in these graphs are I believe enticing. What is concealed is the changes within and between operations: vital statistics seldom come for free!

Mine Capacity Trends - Copper

Figure 1 plots Brook Hunt's forecasts of western world copper mine capacity to beyond the year 2000. Obviously it is difficult, if not impossible to make any meaningful forecast beyond say 1995, as 10 years is sufficient time to discover, evaluate and develop currently unknown deposits. The

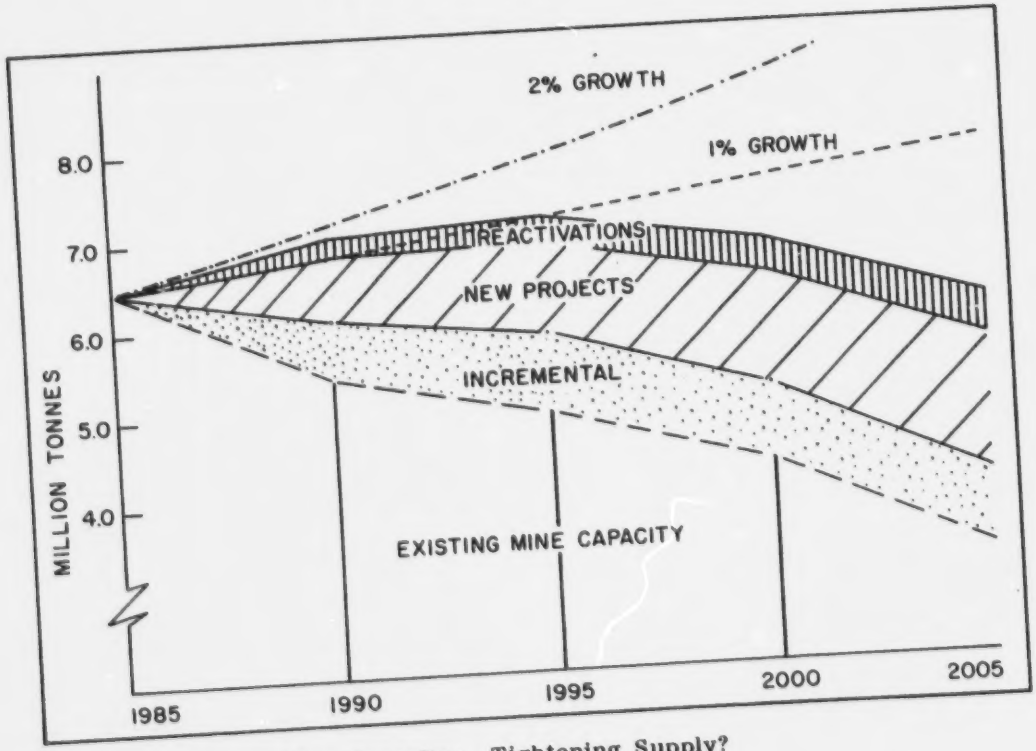

Figure 1. Copper Mine Capacity: Tightening Supply?

analysis to 1995 is done on a mine-by-mine, project-by-project basis and includes careful evaluation of future trends in the underlying cost parameters for existing and possible operations.

Despite the difficulties, we believe the underlying trend to be broadly accurate and certainly worthy of consideration. The figures show that, despite possible reactivations, the average growth in active mine capacity is unlikely to exceed one percent per annum. From figure 1 it is apparent that the main reason for this is the rapid decline in existing capacity. This is projected to fall from just under 6.5 million tonnes of copper currently to under 5.0 million tonnes by 1995.

Thus we are projecting that further closures, plus grade declines, and falling output etc. will reduce existing mine capacity by 1.5 million tonnes in a 10-year period. This is equivalent to a new Escondida every other year.

Clearly, incremental expansions partly offset this decline but, as already discussed, aging mines are less able to expand incrementally. Consequently, by the late 1980s or early 1990s the impact of incremental expansions will fade away appreciably. Our projections suggest that incremental expansions will raise existing capacity by some 800,000 to 900,000 tonnes of copper in the period to 1995, as shown in figure 1.

New projects are forecast to add 1 million tonnes copper to capacity and reactivations could add up to 400,000 tonnes, providing prices rise to levels which justify their reopening, i.e. well over 80c/lb.

Based on the foregoing projections, the net increase in western world mine capacity over the next 10 years is likely to a modest 700,000 tonnes of copper, representing an annual growth rate of only 1 percent. To achieve even this modest growth rate, a significant increase in price to around 80c/lb will be required to bring about reactivations and to encourage financial institutions to commit capital for new projects.

Clearly this suggests a much healthier market is in prospect. Furthermore, all else being equal, it points to a tightening supply situation.

We again stress that, although the detailed capacity projections may prove inaccurate, the overall aggregate picture is likely to be close to the eventual outcome. Certainly it is unlikely that the 1995 capacity projections could be understated by 10 percent and, as you will see from figure 1, this only raises the annual growth rate to just under 2 percent.

Taking a very conservative view of the figures, the conclusion is inescapable that the opportunity for growth and profits lies ahead for the industry. While the transition from a period of oversupply to potential shortage will not be smooth, it could occur more rapidly than anyone is currently prepared to forecast. Two assumptions, however, are built into these forecasts: first, that the mining industry does not repeat the mistakes of the last cycle. The projections assume that only robust, viable projects able to compete effectively within the current and future copper cost profile will be developed. Conversely, that the more marginal propositions are held back to await their slot in the long term demand curve. Second, the forecast assumes that copper prices will remain competitive with alternative industrial materials and that the industry will actively seek to promote copper to ensure it retains its existing markets.

South African Gold Production/Capacity

You will see that the gold data shown in figure 2 has been limited to South Africa. South Africa produces over 60 percent of western world gold, and over half of the total world output.

Two points need to be made before we look at the data presented. First, the graph assumes that production and capacity in a South African context are synonymous. Up to the present, South African mine capacity utilization has always been over 97 percent. Whether this can be maintained in the current difficult environment is an open question.

Secondly, our analysis for gold has deliberately been confined to South Africa. The country's production will continue to dominate world gold supply to beyond the year 2000. However, it must be remembered that, although South Africa has been an important gold producer since the early 19th century, its production is beginning to decline.

What will the trend be in the future? Figure 2 illustrates clearly the rapid decline in South African production beyond the year 1990. It shows also the potential dramatic fall in capacity beyond 1995. By the year 2000, based on Brook Hunt's independent and possibly controversial forecast, gold capacity in South Africa should fall to under 400 tonnes per annum, a decline of 45 percent on current output. The projections to the year 2000 may be in error, and certainly do not take into account the possibility, however remote, that a major new gold field could be discovered and developed in the intervening period.

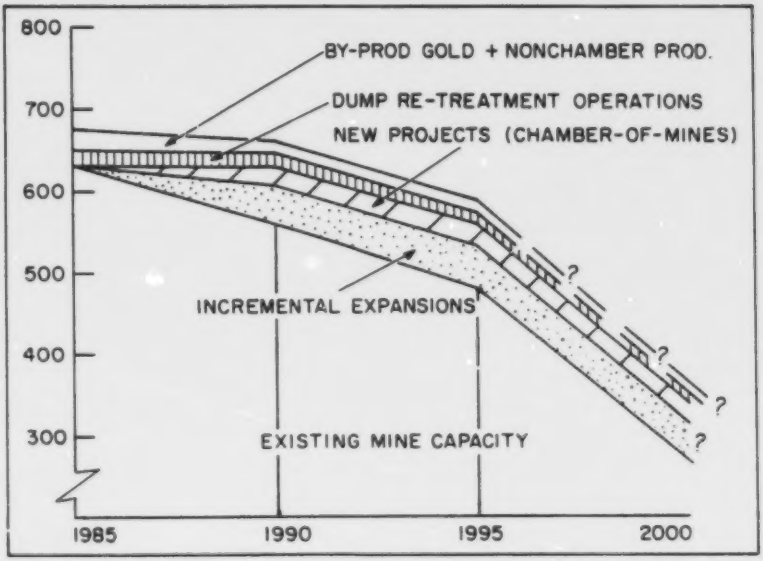

Figure 2. South African Gold Production Capacity: Major Decline Beyond 1990?

The more reliable projections to 1995 show clearly the drop in capacity. Existing Chamber of Mines operations have a current capacity of some 630 tonnes per annum of gold. Excluding incremental expansions and possible new projects, this existing capacity will fall to approximately 480 tonnes per annum by 1995. This rapid decline will be brought about by falling ore grades and mine closures (due to the exhaustion of reserves). Partly offsetting the fall will be incremental expansions which are forecast to add some 55 tonnes per annum and the development of totally new projects which could add a further 25 tonnes per annum.

Despite these important additions, total Chamber of Mines capacity is forecast to fall 11 percent to 560 tonnes per annum by 1995. Similarly total South African capacity is expected to drop from the current 675 tonnes per annum to 590 tonnes per annum by 1995, a decline of 12.5 percent. As figure 2 illustrates, the decline beyond 1995 accelerates rapidly. This trend of falling gold production in South Africa should offer exciting opportunities in other countries.

Production Costs

"In this world all achievements are transitory or at least fragile so we must look at the future", wrote Paul Johnson. And on this note it is important to look at the outlook for production costs. Production costs for most metals have declined substantially over the past four years, an obvious response to weak metal prices. It has been brought about partly by measures taken by the industry, helped appreciably by factors beyond the industry's control. The latter have included currency devaluations, lower energy costs, static or falling wage rates, and a general decline in the rate of inflation. The industry has made major improvements in its overall efficiency, with significant reductions in labour intensity and energy consumption, improvements in inventory and stores control, and so on. It has also been forced to adopt various short-term measures such as high grading, and cost deferments including reduced stripping rates and lower development expenditure.

It is interesting to reflect on the need for greater sophistication in competitive analysis within the metals industry. This is required not only by mining companies but increasingly by banks. Most senior executives in the industry recognize the importance of detailed cost analysis to assess their own competitive position, to evaluate poten-

tial new projects and to understand the overall trends in the industry world wide. At Brook Hunt we have recognized that this alone will not be enough in the future. Our analysis is being oriented increasingly towards a detailed assessment of the underlying cost parameters in order to make meaningful projections into the future. Feasibility studies will increasingly incorporate not only production costs, financial analysis, and environmental impact statements, but also assessments of other even more fundamental variables, such as relative energy intensity and labour intensity. Already the relative capital intensity of a project has become an important development criterion.

So what is the outlook for costs?

While it is probable that labour rates and energy prices will continue to fall marginally over the next few years, for the most part the metals industry faces a period of steadily rising costs, for the following reasons.

i Many operations world wide, faced with weak metal prices, adopted a survival mode with major cost deferments, particularly waste stripping, underground development and capital expenditures. Clearly, if these mines are not to close, a catch-up phase is inevitable.

ii Similarly survival has meant that most mines have been operating to maximize ore grade. Again a cost must be paid. In part this will be manifest by reduction in the economic life of the property, but in the short term more rapid grade declines can be expected with consequential impact on unit costs of the metal product.

iii The massive reductions in the labour force of the minerals industry have largely run their course. Although some minor improvements may be possible and some operations are still over-manned, in general, cost reduction by shedding labour will be difficult to achieve. Consequently, higher productivity will increasingly depend on innovation and capital investment.

iv In those countries which have enjoyed the short-term benefit of devaluations, rising domestic inflation will have an adverse impact on costs. In those countries where devaluation has become an on-going phenomenon, eventually devaluation and inflation go hand-in-hand with little or no impact on costs expressed in

U.S. dollars. For countries which have recently embarked on such a course, devaluations are clearly having an initial beneficial impact on costs, but inflation will rapidly erode this short-term advantage.

v As already discussed, many mines are entering a mature phase. These "old ladies" face rapidly deteriorating cost structures with limited scope for offsetting adverse cost trends by incremental expenses.

vi Another subtle long-term cost factor is arising from the problems being experienced by a number of major underground block-caving operators. With deeper mining, ores have become harder and their caving properties have declined, with the result that a number of mines face a difficult future, possibly having to modify their mining method appreciably with depth, resulting in substantial cost penalties with serious economic implications.

From our observations, mines and mining groups are falling into two distinct camps; those who have a clearly defined long-term strategy to continue reducing costs and improving efficiency, with any short-term measures fully integrated into this overall strategy; and, a second group who are increasingly living from day to day with little or no real grasp of how they will contain costs in the future. This latter group could become vulnerable if another economic downturn occurs in the next few years.

Short-term measures to reduce costs must not be introduced solely on the basis of pure expediency; they must form an integral part of an overall long-term cost reduction strategy. By this means, short-term measures need not be detrimental to the long-term viability of the operation.

A simple example is given. An open-pit operation with severe cost/price pressures was forced to revise long-term mining plans. As part of this revision, the ultimate pit was reduced in size with a consequent small decrease in total available ore. In addition, research had indicated that steeper pit walls were possible in certain sections of the mine and this was also incorporated into the revised plan. The net result was an appreciable reduction in the long-term stripping ratio. As part of an overall strategy it was decided to reduce waste removal immediately, with consequent improvements in mining costs. Crucially, however, this short-term advantage was viewed only as a respite. During the period of lower costs some of the spare equipment capacity was used to relocate future waste dumps,

appreciably reducing future waste haul distances. As a result, total mining costs continued to fall even though the stripping rate had to be steadily increased. We stress that the foregoing example is not intended to teach the obvious; it is presented only by way of illustration. The concept of a fully integrated strategy is a mark of good management.

One obvious result of the difficult period which has faced the industry is that it has focused attention on the absolute necessity for good management at all levels in the industry. It has also underlined the importance of good strategic planning, able to take full account of the cyclical nature of the metals industry. A key feature of such strategies is a rapid flexible response to changing circumstances.

Another aspect is that increasingly, prudent mining groups worldwide are facing the reality that it is not good enough to depend on metal price improvements to solve problems, the problems must be solved by steadily increasing productivity and efficiency. "Plan for low metal prices, hope for higher prices", should be the watchword.

Taxation Considerations

This leads us into the area of tax reform in developed countries which, if fulfilled, could help bring about a renaissance of mining in these countries. Mining can no longer be treated as the "milch cow", to be drained by windfall taxes every time the metal markets pick up and ignored when metal prices plummet and profits turn to losses. Sound policies are needed, based on the cyclical realities of the industry.

Throughout the developed world there is need for a unified sliding scale tax formula for the mining industry, on the lines of that applied to the gold mining industry in South Africa. This formula essentially incorporates two concepts:

- tax rates should vary depending on the level of annualized profitability;

- below a certain level of low profitability, tax becomes negative with a consequent tax rebate (state assistance).

This is illustrated in figure 3.

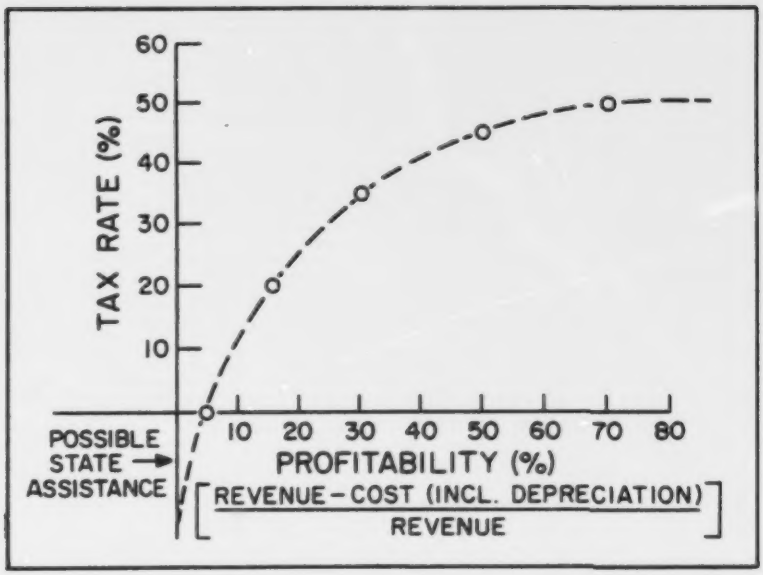

Figure 3. Sliding Scale Tax

The slide shows a possible sliding scale tax curve. Tax Rate is shown on the "y" axis and profitability on the "x" axis. Profitability for this purpose is defined as:

$$\frac{\text{Total Mining Revenue less Costs (including depreciation)}}{\text{Total Mining Revenue}}$$

Various examples are given in table 1.

Table 1

EXAMPLE OF EFFECT OF SLIDING SCALE TAX

				Sliding Scale Tax		Standard Tax	
Example	Revenue $	Costs $	Profit $	Rate %	Paid $	Rate %	Paid $
1	100	50	50	45	22.5	45	22.5
2	100	70	30	35	10.5	45	13.5
3	100	85	15	20	3	45	6.8
4	100	95	5	nil	nil	45	2.3

In example 1, when total costs (including depreciation) are half of revenue, then the tax rate under this possible tax formula would be identical to standard tax, i.e. 45 percent on profits, such that tax would amount in both cases to $22.5.

At 30 percent profitability (example 2), the sliding scale tax rate would fall in this example to 35 percent, compared with 45 percent under standard tax. Tax paid would decline to $10.5 compared with $13.5 under the standard rate system.

The differential increases at lower profitability. At 15 percent profitability (example 3) the tax rate drops to 20 percent, such that the tax paid is less than half i.e. $3.0 compared with $6.8 under the standard regime.

If profitability (as defined) falls to only 5 percent (example 4), that is to say, if costs (including depreciation) total 95 percent of revenue, then the tax rate is reduced to zero. Below 5 percent profitability, there is the possible provision of state assistance, either as tax rebates or even temporary subsidy.

Clearly this description is highly oversimplified. For example, the rate at which capital can be depreciated is not specified. In our opinion this should be entirely at the discretion of the company concerned and should be variable from year to year. No company investing in a mineral project should pay any tax until it has recouped its original investment.

It is appreciated that, in most countries, operating with a standard rate taxation system that includes capital allowances, inventory adjustments, etc. results in a taxation system approximating a sliding scale tax. Nevertheless, the proposed scheme has the advantage of simplicity. It is easily understood by both operators and the public, reducing the likelihood that politicians will get on the "windfall tax" bandwagon. In addition, such a taxation system is a clear recognition by government that taxing a highly cyclical resource industry must be done with great care to ensure the long-term healthy survival of a basic national asset.

Other areas where government can cooperate closely with the mining industry to ensure a better long-term future is the elimination of competition between local taxes, i.e. state and federal taxes. Equally important is the elimination of hidden taxation and excessive front-end taxation. In the latter case we refer to heavy ad-valorem tax, royalties on output, or export taxes. Hidden taxation usually takes the form of import duties on plant and equipment. If the power utilities, railways, harbours etc. are federal or state-owned, it can take the form of excessive charges, well above the world norm. The state of Queensland in Australia charges punitive freight rates to its mineral industry, double the actual cost of operating the railways. This has been a great cost penalty to the base metal operations at Mt. Isa and has made Australian coal appreciably less competitive, with consequent loss of sales, and probably an overall loss in total tax revenues for the state government.

Taxation should be based on the ability of the company to pay. It must be entirely based on profitability, taking full account of the need for large on-going capital investment.

Conclusion

In summary, grade trends, infrastructure, access to capital, security of supplies, and security of assets should be factors which favour investment in developed countries. In

developing countries, however, access to capital has been and will continue to be difficult for all but the most unique projects. I expect the World Bank to get more deeply involved in project financing in Third World countries over the coming years.

All great discoveries are made by men whose feelings run ahead of their thinking. And so the metals industry must meet the challenge of the existing and emerging group of industrial materials. The attack must be two-pronged. First, by continuing to reduce its cost structure through innovative thinking, by further reductions in energy, labour, and capital intensity. Second, the industry must be more aggressive in defending its markets and seeking new outlets under the umbrella of an overall strategic plan rather than by setting up ad hoc arrangements which have a tendency to protect and perpetuate empires.

"In almost all philosophy doubt has been the goad and certainty has been the goal", wrote Bertrand Russell in Portraits from Memory. And should the metals industry be thrust into renewed activity by these doubts about the future, then the goal of growth and prosperity will surely be attained.

STRUCTURAL CHANGES IN THE CANADIAN ZINC MARKET

John J.L. Davies

Canada is the world's largest mine producer of zinc. In 1984 it produced 1.2 millions tons, or 24.3 percent of the free world total of 5.0 million tons. This is down from the 30 percent level we enjoyed in the early 1970s. While production has remained quite static at current levels for some ten years, our percentage of the rising total has slipped. Australia, Peru, Mexico and the United States are our principal competitors.

Table 1

CANADA'S ZINC INDUSTRY

	1984	
	Metric Tons	Market Share
Zinc mine production	1,215,000	24.3%
Zinc metal production	683,000	14.0%
Zinc metal consumption	141,000	3.1%

In 1984 Canada's metal production totalled 683,000 tons, or 14.0 percent of the total free world production of 4.84 million tons. Unlike mine production, Canadian metal production has been increasing. In 1970 we produced 413,000 tons, or 10 percent of the world's total. Europe taken as a whole accounted for 39.6 percent, and is the world's largest single metal producer, followed by Japan with 15.4 percent.

Canadian zinc metal consumption in 1984 was 141,000 tons, or 3.1 percent of the total free world consumption of 4.7 million tons. Canadian consumption of zinc has remained static for ten years.

Table 2

MINERAL PRODUCTION OF CANADA, 1983

	Quantity	Value $ million
Copper (tons)	625,000	1,307
Gold (kg)	70,746	1,186
Iron ore (tons)	32,382,000	1,143
Zinc (tons)	971,000	1,116
All others		2,484
Total metals		7,238

The value of Canadian zinc production in 1983 was $1.12 billion, the fourth highest mineral value produced following copper, gold and iron ore. Exports were valued at $959 million. There are 14 zinc mines and 4 refineries that employ over 18,000 Canadians. By any measure zinc is a large and important business in this country. A careful look at this industry shows that the winds of change are passing over and sapping the vitality of former years. Its market lacks the sparkle and glamour of past years. A loss of vision and confidence about the future has eroded investments into new mines and in this is written serious implications about the future.

Change is the process by which the future invades our lives, and it is important to look at it closely. One way to measure change is to study the past to shed light on the present. Change has been with us from the beginning of time. It is fascinating to study, often difficult to accommodate and generally feared by all. Those of us who cope well with change seem to have a richer, better developed sense of what lies ahead of them than those who cope poorly. Hopefully, this seminar which is focused squarely on the changes affecting our mining industry will give us all a clearer perspective of the future.

The Belgians first identified zinc metal and its refining technology in the mid-18th century. Before the century closed and in the early stages of its industrial revolution, the U.K. discovered how to manufacture brass using Cornish calamine, and quickly acquired dominance of this industry, controlling both supplies and price. The industry prospered through the 19th century. By the early 1900s the centre of gravity of the zinc industry swung from

Europe to the United States, where industrial production was increasing and demand expanding exponentially. Being very well endowed with zinc and sheltered from the ravages of the European wars, the United States rapidly dominated production and price. The industry prospered and expanded through to the 1960s. At that time production peaked, costs rose, technical obsolescence set in, consumption faltered and once again the centre of gravity in the industry began to shift to other markets. Change has left its footprint on this industry throughout history.

Zinc is an industrial commodity and its markets are found in all countries with an industrial base. Historically there has been a close relationship between industrial growth as measured by GNP and consumption. During periods of high growth zinc consumption rises, and during recessions it falls. Because of its broad industrial use, zinc consumption has always been a sensitive indicator of the economic health of a nation. An examination of recent statistics shows that the ratio of zinc consumption per unit of GNP, often referred to as "intensity of use", for all the major industrial economies of the world has been falling, while this ratio is expanding in the developing countries. This is the first important measure of change in the zinc markets, and the causes are due to the following factors:

- The economies of most OECD countries are maturing. As they mature, the manufacturing component of the GNP shrinks relative to the service-oriented sector.

- Manufacturing methods are changing. Industrial technology has become more sophisticated with the growing use of the chip, and electronics use less metal.

- The efficiency of zinc usage has improved with time. This change has been forced on industry by rising costs, particularly for oil, and a desire to minimize the use of materials. Improved design and engineering technology has led to a reduction of weight. Small is beautiful!

- Intense and aggressive competition by sellers of competing materials has led to an erosion of the markets for zinc. The driving force behind the zinc industry has long been production. As a result its marketing skills have lagged.

During the massive reconstruction of Europe and Japan during the 1940s and 1950s, demand for all metals including zinc rose dramatically, particularly in the highly industrialized countries of the OECD as shown in table 3. However, as infrastructure development matured and the birth rate declined, the growth rate in metal consumption in these countries began to ease. Conversely demand began to pick up in non-OECD countries as governments in these countries financed massive programs to raise the standard of living of their citizens through industrialization.

Table 3

FREE WORLD ZINC CONSUMPTION COMPOUND GROWTH RATES
(percent)

	1950-73	1973-84	1980-84
OECD Countries			
Europe	4.62	-0.42	0.08
United States	1.75	-3.14	2.23
Canada	4.23	0.96	1.47
Japan	12.75	-0.50	0.59
Australia	3.75	-3.77	-4.54
Weighted average	3.63	-0.95	0.72
Non OECD			
South America	9.54	3.26	-2.70
South East Asia	10.69	7.21	7.81
Africa	9.23	2.87	0.48
Weighted average	9.96	2.20	5.05
Total free world	4.35	-0.26	1.22

This change has boosted demand for industrial metals and helped to sustain demand. As a result the driving force behind the markets for zinc is again swinging to areas of growth which now lie in the non-OECD countries.

Galvanizing dominates all market applications for zinc, accounting for 46 percent of the total. This market is

growing, partly because other applications have contracted but most importantly because the process has stood the test of time and proven to be the most cost effective method of protecting steel from corrosion. The process is well developed and requires little sophisticated technology. As a result it is widely used in developing countries and is the main thrust behind zinc's rising consumption trend in these countries.

New alloys have been developed to enhance the life of zinc coatings and to keep competing materials at bay. In response from car owners, automobile manufacturers are increasing their use of zinc-coated steel to improve durability from the ravages of salt corrosion. As a result, galvanizing lines in North America, Europe and Japan have operated at capacity for some time, and there is now a massive investment underway in building new lines, mostly using new electrogalvanizing technology.

Diecasting follows at 18.0 percent. This application has lost ground over the past 15 years due to substitution by aluminum, plastics and magnesium, a dramatic increase in imports, technical obsolescence in the diecasting industry and economizing through the introduction of thin-wall diecasting technology. While reducing the weight of a zinc casting, this technology has at least preserved a market. Consumption of zinc by the diecasting industry in the USA has fallen from 35 percent of the market to about 18 percent currently. Much of this change has resulted from the loss of zinc in the U.S. automobile, which has fallen from about 70 pounds per car in the late 1960s to 23 pounds today. The pressure to reduce the weight of the car is one cause for change.

Brass accounts for 19.0 percent of the market. Brass, an alloy of copper and zinc, is a widely used industrial metal having a low value-added component but wide end-use applications. Globally the industry has restructured into a few massive brass producers, mostly located in Europe and Latin America. These plants use the latest state-of-the-art technology to minimize their costs and have effectively forced most of the smaller, high cost, technically obsolete plants out of business. Many of the North American plants have closed so consumption of zinc by the brass manufacturers has fallen.

All other markets are small, reasonably secure from a technical standpoint and slow growing due to changes underway in the markets. For instance, about 7 percent of zinc consumption is used as oxide in the vulcanization of rubber - mostly tires. The steel-belted radials, which have doubled the mileage for tires and significantly reduced

demand for replacements, have obviously affected the consumption of zinc oxide used for this application.

Change always brings with it new opportunities. For zinc this has come from China. This country has announced a new long-term policy to expand its economic base to improve the standard of living of its citizens. The expansion of the infrastructure has begun, and this has turned this country from a modest exporter of zinc into a huge importer. China has turned to the West to meet its requirements of zinc and for the past three years has purchased over 200,000 tons of zinc per year, opening a massive new market for this metal. This new demand has been a lifesaver for the zinc industry.

A few words about the price of zinc might be useful, as price is always a sensitive measure of change. Figure 1 shows that a jump in price in both real and current dollars took place between 1973-74, coinciding with a rise in the oil price.

The most notable signs of change in figure 1 are the following. First, the price in current U.S. dollars averaged 13.8¢/lb. between 1950 and 1973, rising 180 percent to 38.6¢/lb. between 1974 and 1984. Coincidentally with this period, the average real price in 1984 dollars rose from 42.9¢/lb. to 53.1¢/lb. The price averaged 48.6¢ in 1984 and is currently 41.0¢/lb., or 22 percent below the last 10-year average. Between 1950 and 1984 the U.S. price averaged 46.1¢/lb.

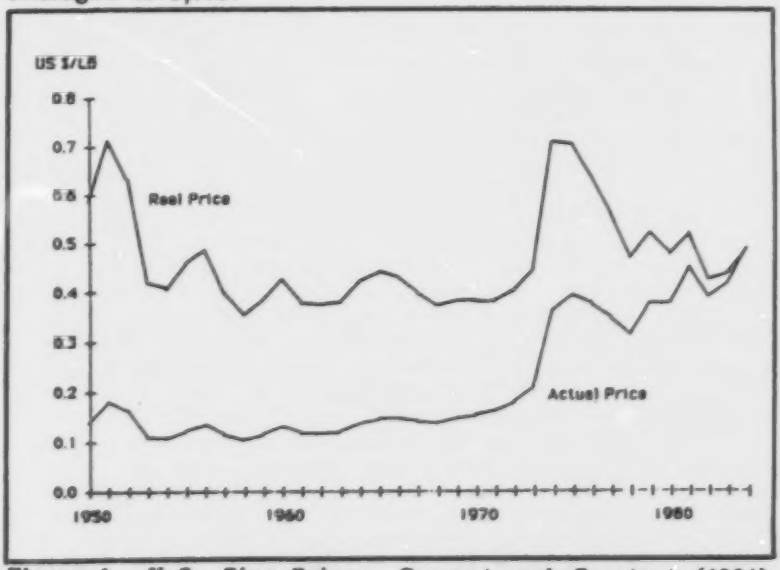

Figure 1. U.S. Zinc Prices, Current and Constant (1984) Dollars, 1950-84

Second, recent deflationary pressures in the market have wiped out the benefits of the real price increase experienced during the 1970's.

Producer stock changes are a sensitive measure of the supply-demand relationship in the market. When stocks rise, prices fall or vice versa. However, this long-term historical relationship seems to be changing: while stocks have been falling steadily since 1982, prices have performed erratically, rising initially with lower stocks but then falling even though stocks have continued to fall. Reasons for this apparent change include:

- the current high cost of money;
- perception in the markets that shortages are no longer likely;
- better management of inventories;
- widespread acceptance of switching, which reduces the pipeline;
- improved transportation services;
- increased consumer access to the global supply sources.

Zinc prices, particularly on the LME, are far more volatile today. Prices commonly change as much as 10¢/lb. in a month, an unheard-of swing ten years ago. Market information today is being transmitted around the world at an increasing speed. This information is available through computer terminals to a vastly expanding, "need to know" market. The result is that we now have a supersensitive market in which small changes in supply-demand relationships can and do lead to unrealistic price swings as the herd instinct takes over.

The relationship between price and currency values is a further factor that has affected the zinc price. The currency used to price zinc world-wide is the U.S. dollar. The result has been dramatic in those countries whose currencies have weakened against the dollar, with the price in some major consuming countries doubling over the past few years.

The treatment charge for zinc concentrate is fixed in U.S. dollars. This has provided a windfall gain for custom smelters located in those countries having weak currencies. As a result, most of the European custom smelters, who suffered years of serious financial losses, are once again profitable. In fact some are now beginning to plan expansions to their capacities.

A careful look at history will show that much of the changes we are experiencing in the zinc business date back to the early 1970s. The oil price increase in 1973 and

1974 was one significant factor. Higher fuel costs led to the downsizing of the automobile to improve fuel consumption through weight reduction. This in turn caused a massive change in demand for materials and labour. While it started with the automobile, the process of change flowed through to other industries. The net effect has been that a given standard of living no longer requires the same amount of zinc as it once did. The result is a classic case of structural change - an irreversible form of change that occurs periodically throughout history and which is often accompanied by social turmoil.

A large part of the rising prosperity and economic performance of the industrial world during the post-war period stem from the fact that real prices for many vital commodities declined. Lower real prices were due to:

- steady investments made into new technologies that reduced the processing costs, improved productivity and the passing of the cost benefits into the markets through price competition;

- the abundance of raw materials, which ensured that the spectre of supply shortages never became a serious reality;

- increasing the economies of scale by increased capital investments.

These factors spurred investment and growth in Canadian mine production, which rose from 280,000 tons in 1950 to a peak of 1.3 million tons in 1977. During the 1970s, a period of high inflation, prices rose but were offset by rising costs, higher taxes, Third World competition, shifts in markets due to closures of obsolete refineries, and a fall in new investment due to unsatisfactory financial returns. As a result growth began to falter. Although production has been maintained reasonably in line with the 1970 levels, Canadian mine production is now in a period of decline, both globally and nationally.

Canadian metal production has held up rather better. Our refineries have benefited from a long period of steady investment to modernize technologies, reduce costs through increased productivity and to comply with Canadian government policies of further processing. Most refineries are now cost competitive with the best in the world, and in addition have the added strength of downstream integration with mines.

There is convincing evidence today to suggest that the longest period of growth and prosperity the world has ever known ended in the late 1960s. Since that time almost every facet of life has been subject to accelerating change. A time of change brings with it uncertainties about the present while the future becomes increasingly more invisible. Zinc, like all metals, is passing through uncertain times due partly to structural change, which I have attempted to identify, and partly cyclical change. The net result has been painful to the business. However, it is reasonable to expect a return to prosperity will recur with an improvement in cyclical change, but structural change will be ongoing and probably intensifying.

The metal has a number of unique properties which industry has successfully adopted for the betterment of mankind. Some uses, such as galvanizing, have a proven record of success and have survived the test of time. The steel producers are the largest buyers of zinc and, although this industry is experiencing extremely difficult times which has resulted in widespread contraction and serious financial hardship to the industry, demand for coated steel products is on the rise. There is now considerable expansion under way in this value-added component of the steel business.

Rising demand for coated steels is not an unexpected occurrence. Consumers today have become more selective and demanding in the products which they buy. Having a greater choice available to them, consumers are seeking out products which have design and quality excellence. The throw-away mentality so prevalent in our society a few years ago is rapidly disappearing, perhaps as a result of rising affluence and the aging society. Zinc adds quality to steel and thus has benefited from the present trend towards quality. I say present because there is no certainty that the future is secure. Nothing today is; and unless an industry is prepared to defend its markets with vigorous promotion and ongoing market development, substitution by competitive materials is a distinct reality.

Zinc's use in die castings is under fierce attack. It has lost an important share of this market and although the metal has superb engineering properties and castability and is truly hard to beat as a die-casting material, it is unlikely to recapture the markets it has lost. The contraction in the business has meant a large loss of people who sell zinc castings, fewer die casting machines available, a loss of technology and skills available to the industry, and some loss in confidence. Retaining the status quo for this mar-

ket will require new technology, new alloys, new investments and the development of new marketing skills - a commitment which I believe the industry will make.

Change has affected some of the other important markets for zinc as mentioned earlier. However, chemicals and related products offer some of the best growth opportunities based on the unique cost effective properties of this metal. An example of a recent success was zinc's acceptance in 1982 by the U.S. Mint for the manufacture of the U.S. penny. As a result, in 1984 the Mint purchased over 45,000 tons of this metal, which was rolled into sheet, stamped into 1¢ blanks and coated with a thin layer of copper before being faced.

A bit of trivia for those interested: There are 181 pennies to a pound of zinc, or 362,000 to the ton. The Mint report that 92 percent of all 1¢ pieces that are placed into circulation disappear immediately after introduction, probably into piggy banks. Stamping 1¢ pieces out of zinc has thus become a unique and valuable market for this metal.

The driving force behind any business is its markets. If the markets are changing, the business has no alternative but to change with them. Canada's strength in zinc lies in its mine production, partly because the country is well endowed with this mineral and also because of our expertise and great mining culture. During the long period of economic prosperity, the zinc industry grew and prospered. In recent years, however, it has become quite fragile, being burdened with high and rising costs, declining ore reserves, unsatisfactory financial performance and almost a total lack of new investments. Its viability is waning and it has started to lose some of its former importance in the market. Zinc is no longer a growth industry in this country. However, judging by existing investments, we will continue to play a key role in the industry and unquestionably should expect some return to prosperity of former days.

A strategy for survival should include the following measures:

- Canada should not seek to expand its mining base unless high rates of return are possible;

- cost management must become the highest priority of any company with realistic prospects of survival - rising costs are a serious problem;

- higher prices are not the answer to rising costs since they give rise to substitution and shrinking markets;

- new technologies aimed at reducing unit costs of mining and higher metallurgical recoveries must be developed if zinc mining in Canada is to remain competitive and economic;

- all levels of government must resist pressures for subsidies to the industry. Subsidies discourage excellence by supporting the weak;

- industry's philosophy must change from production driven to market driven enterprise. Demand for zinc can only be increased through technology transfer and innovation in new products, developed in the research laboratories and brought into the market, along with the promotion of existing markets.

THE WORLD POTASH INDUSTRY - CHANGES IN SUPPLY AND DEMAND

Douglas A. Karvonen

Introduction

Potash is a general term used to describe a large number of potassium-bearing materials. A few of these materials, which occur as soluble salts in bedded underground deposits or as brine in lakes or in seabeds, account for all of the potash produced for use in agriculture and industry.

About 95 percent of potash produced is used as a fertilizer in agriculture. Potassium (K), along with nitrogen (N) and phosphorus (P), makes up the three basic elements necessary for healthy plant growth. The remaining 5 percent of potash is used in industry, initially converted to caustic potash (KOH), which becomes a basic chemical building block necessary in manufacturing a wide variety of products including dyes, paints, insecticides, soaps, television tubes and batteries.

More than 90 percent of potash used in agriculture is produced in the form of potassium chloride or muriate of potash. Most of the remainder is in the form of potassium sulphate or potassium magnesium sulphate. The agricultural potash is manufactured in a variety of sizes and colours depending upon the market and ultimate blending process (either bulk blending or granulation) used to combine it with nitrogen and phosphorus based products. The colour, ranging from red to white, depends on the natural colour of the ore as well as the procedure used for refining. Agricultural grade potassium chloride is generally 95 percent pure or better while the chemical grade is greater than 99 percent.

Scientists decided years ago to express the potassium content in terms of K_2O equivalents and so most potassium products are graded and sold on this basis. Pure potassium chloride is 63.2 percent K_2O and agricultural grades are therefore generally a minimum of 60 percent K_2O. (To convert tonnes of K_2O equivalent to actual product tonnes of KCl it is necessary to multiply by 1.58; conversely, it is necessary to multiply KCl tonnes by 0.632 to get K_2O tonnes.)

Most of the potash produced in the world is first mined conventionally either by blasting or by mining machines. After being hoisted to the surface it is refined

by a series of steps involving crushing, flotation (a wet mechanical process where potash is floated off from the waste, which is largely sodium chloride), centrifuging, drying and screening. Fines are usually dissolved and recrystallized either as separate products or blended with floated products.

Solution mining, by dissolving potash beds with heated brine, is utilized as a production technique by one mine in Saskatchewan (Kalium Chemicals, a division of PPG Industries Canada Ltd.). After the brine is pumped to surface, evaporation and crystallization techniques are used to produce the finished products. This process can be used where beds are too deep to mine conventionally. However, energy costs are a large component of processing costs because of the need to evaporate all the water. The evaporation/crystallization route is used in other parts of the world, such as in France and the Soviet Union, as a refining technique even though the ore is mined conventionally.

The lake brines can be a source of potash in certain parts of the world where the potassium content is high enough. For example, Arab Potash Company in Jordan and Dead Sea Works Ltd. of Israel produce potash from the Dead Sea by using the sun, initially to concentrate the brine in ponds, followed by flotation and crystallization. Similar methods are used by Great Salt Lake Minerals in Utah. Other potential sources of lake brines exist, although they are not large in number. One such lake (Lake Cha-erh-han) in northwest China will likely become a more significant producer in the late 1980s or early 1990s. Electrostatic separation of dry ore is also practised as a refining technique in West Germany.

Known world potash reserves are plentiful.[1] Estimates have placed Saskatchewan's underground reserves alone as adequate to meet world demand for more than one thousand years. Saskatchewan has been estimated to have more than 40 percent of world reserves. Large underground reserves also exist in the Soviet Union. Although less extensive, substantial underground reserves exist in East and West Germany. France, Italy, Spain, the United States, the United Kingdom, Chile, and New Brunswick in Canada all have deposits that are worked for various potassium salts. Substantial reserves are contained in the Dead Sea brines and the brines of Great Salt Lake. Searles Lake and the

1. United States Department of the Interior, Bureau of Mines, Mineral Commodity Summaries - 1985 (Washington 1984).

Great Salt Lake Desert in the United States and the salt lake in Qinghai province in China make up the rest of worked sources. Manitoba in Canada could potentially become a source of potash as a result of reserves which are an extension of the Elk Point basin, and are similar to those mined in Saskatchewan.

Altogether, about 18 sources of potash in 13 countries are being worked.[2] Potential potash reserves, yet unmined, have been discovered in a number of locations around the world including Australia, Botswana, Brazil, Chile, Egypt, Ethiopia, United States (Michigan), Saudi Arabia and Thailand. Some of these will become producing areas during the next decade.

Production

The discovery of potash salts in Germany in about 1840, followed by a recognition of the need for potassium in plants, led to the birth of a modern potash industry in 1861.[3] In two years, the number of plants had increased to 14, and by 1900 over three million tonnes of salts were being extracted. During the early 1900s, potash was also discovered in France and after World War I, French and German companies competed quite aggressively for world markets. Declining prices and profits led the German producers to form a cartel, with the result that they were able to maintain profitability and firm prices.[4]

This first phase in world potash production is characterized by a period of fairly rapid growth, a few suppliers working as a cartel, and stable prices. During the early 1920s the number of active mines operating in Germany was reduced while production continued to increase. Production from Germany reached one million tonnes K_2O in 1927.

What can be designated as the second stage in the development of the world potash industry began in the late 1920s and early 1930s with the first production of potash from Spain, Palestine, Poland, Russia and the United States. Initially production from these new sources was quite small, but as it grew it had its effect on world

2. British Sulphur Corporation, The, World Survey of Potash Resources, Fourth Edition (London, 1985), xiv.
3. World Survey of Potash Resources, xiii.
4. W.E. Koepke, Structure, Behaviour and Performance of the World Potash Industry, Department of Energy, Mines and Resources, (Ottawa 1973) pp. 74-80.

prices. During this period, arrangements were made with the cartel in Europe and prices were stabilized. The world-wide depression and World War II interrupted the production of world potash. With Germany divided after World War II, the United States became the world's largest single potash producer. Most of the U.S. production was concentrated in the Carlsbad, New Mexico area. The emergence of new potash producers in a number of scattered geographic locations and the decline in the influence of the German/French cartel during this period can be considered a significant turning point in the world potash industry. When the United States emerged as a major producer of potash, along with growing demand in North America, the concentration of the industry shifted away from Western Europe.

During oil exploration in the early 1940s, potash was discovered in the province of Saskatchewan, initially at a depth of some 7,600 feet, and later at shallower depths. Until 1951, the Government of Saskatchewan was able to elicit little industry interest in the potash reserves. An early attempt at shaft sinking in 1952 was a failure because of technical and financial difficulties and the project was abandoned due to flooding.

A second attempt was made by Potash Company of America, a New Mexico producer. This attempt was more successful, and in 1958 the first potash ore was hoisted from a mine in Saskatchewan. This mine was later forced to close because of water seepage. It took another six years before it reopened, but it remains in production to this day.

Another company, International Minerals and Chemical Corporation, began attempts to sink a shaft in 1957, and in 1962 the first continuous production of potash from Saskatchewan began.

These early years presented significant technical challenges to the potential Saskatchewan potash producers because of the extreme difficulties encountered in shaft sinking through a high pressure, water-bearing formation known as the Blairmore. While other conventional potash operations that followed experienced some difficulties in shaft sinking, none of these were as severe as those experienced by the first three companies.

By 1970, the Saskatchewan potash industry consisted of ten active potash mines, nine of which were conventional operations and one a solution mine. The ownership of these properties was made up of three categories: those producers which had operations in the Carlsbad area of New Mexico; one company which was owned by French and

German interests; and the third category made up of new entrants which previously had not been involved in the potash industry.

During the 1960s potash production of commercial importance was developed in Italy and the Republic of Congo. Italy still remains a producer, but the mine in the Republic of Congo was forced to close in the 1970s as a result of water seepage.

In 1974 a mine came into production in the United Kingdom. During the early 1970s production expanded quite rapidly in the USSR with major increases from the Byelorussian Republic as well as the Urals region. During the late 1970s, several expansions were made at the mining and refining operations in Saskatchewan.

The Potash Corporation of Saskatchewan, a Saskatchewan provincial Crown corporation, was formed in 1975 and in 1976 began a process of acquisitions. These acquisitions, which took place between 1976 and 1978, resulted in the corporation acquiring approximately 40 percent of the productive capacity of the province, giving the corporation sole ownership of three potash mines, 60 percent ownership and operating responsibility for a fourth, and acquiring ore reserves and a production agreement for about 25 percent of the production from two mines of International Minerals & Chemical Corporation (Canada) Limited. The acquisitions followed a long period of negotiations and legal actions surrounding regulations and taxation levies established by the government of the day.

With the expanding markets of the late 1970s, PCS proceeded with expansions at four of its five divisions. Additional expansions were planned which included a new greenfield potash mine. However, the world-wide recession and downturn in potash markets in 1981 forced cancellation of these additional projects.

During the late 1970s some minor expansions were also made by the mines owned by the private sector in Saskatchewan. All of the expansions by PCS and other companies operating in Saskatchewan (with the exception of the PCS Mining Rocanville Phase II Expansion of approximately 600,000 tonnes KCl completed in 1981, and the Lanigan Phase II Expansion of approximately 2 million tonnes KCl which will be complete in 1985) have been of the bottlenecking-type of between 150,000 to 400,000 tonnes KCl per annum. The productive capacity of the Saskatchewan industry is presently about 13.7 million tonnes KCl, or 8.3 million tonnes K_2O and this capacity is owned by seven companies, which represents approximately 28 percent of the world's productive capacity. Industry sales grew to more

than 7.0 million tonnes K_2O with a value of about $1.0 billion in 1980. Some decline in sales and revenues as a result of the world wide recession have taken place since then although there has been a recovery in 1983 and 1984 (figure 1).

In the 1980s several new regions came into production, in addition to expansions in Saskatchewan, the USSR and Israel. These are Jordan with production from the Dead Sea brines and the province of New Brunswick with two conventional mines which are both still in the start-up phase. A project in Brazil is scheduled to begin production in 1985.

In 1984 world production was about 29.5 million tonnes K_2O. The following is an approximate breakdown: USSR 33 percent; Saskatchewan 26 percent; East Germany 12 percent; West Germany 9 percent; France 6 percent; United States 5 percent; Others including Israel, Jordan, China, Latin American, Spain, Italy, and the United Kingdom 9 percent.

What could be described as the third period of major change in the world potash industry was the beginning of the Saskatchewan potash industry in 1962, followed by the fairly steady and rapid increase in production up to 1981, which could be considered the end of the period. During this period Saskatchewan producers became major factors in world export markets as 95 percent of all Saskatchewan potash is exported outside of Canada.

Probably 1981 marked the beginning of the fourth period of structural change for the potash industry. It has been characterized by fluctuating production rates, resulting from unstable world markets, as well as the entry into the industry of new producers in Jordan, New Brunswick and most likely, Latin America. Resources have been discovered in many parts of the world and while some of these deposits will be difficult to develop, plans for their exploitation continue. Some of these discoveries are in less-developed countries where governments are very interested in seeing these developments, in some cases for the foreign exchange earnings that might be saved by domestic production of a vital resource, but often as not for the foreign exchange to be made.

World potash production, which grew at an average rate of about 7 percent per year during the 1960s and 1970s, has shown very little growth in the 1980s. In fact, world production fell about 12 percent in 1982, recovering to a new record in 1984. Capacity increases, based on forecast growth rates for demand which were much higher and planned for the late 1970s, are presently coming on

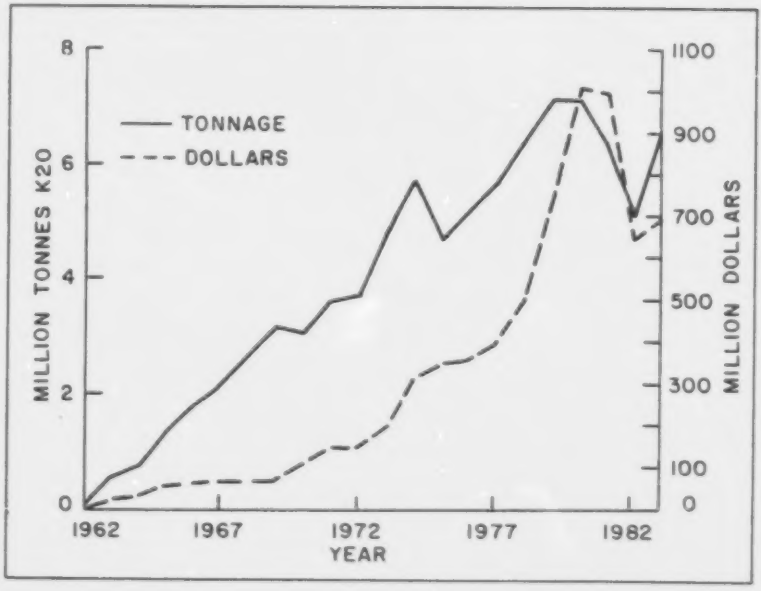

Figure 1. Saskatchewan Potash Industry Sales, 1962-83

stream. Production capacity is likely to continue growing at 5 to 6 percent a year until 1988 when most of the expansion plans now committed will be completed and available.

Demand

During the first two stages in the development of the world potash industry, demand was largely centred in Western Europe. Eastern Europe and North America began to emerge as markets in the 1930s. It was not until the latter part of the second period, during the 1950s, that the early signs of export potential in Asia (Japan) became apparent.

Throughout the first two periods and until the mid-1960s, demand was adequate to take all of the production available. The two World Wars created disruptions, of course, but available information suggests that the industry was profitable during this period.[5]

During the 1960s the Green Revolution resulted in a steady 6 to 7 percent per annum growth rate in world potash demand. The growth rate continued on into the 1970s at a fairly consistent rate except for some disruption created by the OPEC oil crisis in 1973. With the exceptions of Western Europe and Japan, which began to show signs of becoming a mature market during the early 1970s, demand grew in most regions of the world.

While demand growth was strong during this period, a severe oversupply developed in the late 1960s because of the sudden expansion of capacity in Saskatchewan. In 1969 the Government of Saskatchewan brought in a potash prorationing program in an attempt to halt the sliding prices and regulate production. The program had the desired effect of raising prices and was operated for approximately three years until potash demand began to catch up to production capacity and the program was disbanded. The recovery in potash prices placed against a background of rapidly rising oil prices and general upward revisions to resource taxation in several parts of Canada resulted in the Saskatchewan government applying a taxation levy called a Reserve Tax in an attempt to capture a portion of these new revenues. Although modifications were made to the tax and royalty scheme in the late 1970s, the modified system (called the Potash Resource Payment Agreement) is still in effect. In 1983/84, it raised approximately $40 million in

5. Structure, Behaviour and Performance of the World Potash Industry, pp. 48-51.

revenues for the provincial government. This payment is quite sensitive to potash price and the revenue collected by the provincial government is down substantially from the period of peak prices in 1980 and 1981.

By 1981, the impact of the world wide recession and the huge grain surplus in the United States resulted in the U.S. government bringing in an acreage reduction program called "Payment in Kind" which resulted in a dramatic drop of nearly 20 percent in potash sales to North America in 1982. This event and the world wide recession signalled an end to the generally even growth which had been experienced in world potash consumption.

Because of the weak demand in the USA and the financial problems of Latin America, there was no growth globally between 1978 and 1983. Although 1984 appeared to set a new record at about 28.3 million tonnes K_2O, the current outlook is not very encouraging. Broken down by region, demand in 1984 was as follows: East Europe 36 percent; West Europe 22 percent; North America 21 percent; Asia 12 percent; Latin America 6 percent; Africa 2 percent; and Oceania 1 percent.

Structural Change During the 1980s and the Future

So far, this paper has devoted considerable attention to describing the world potash industry and the major events which have in the past signalled the beginning of permanent change. The rest of the paper will attempt to describe the present period which began in 1981 and project where the industry is heading.

Simply stated, the situation facing the industry today is difficult. It includes the following:

- an economic crisis in North American agriculture;
- a heavy debt load and weak purchasing power in less-developed countries;
- a growing tendency towards countertrade;
- oversupply of potash resulting from demand forecasts that were too optimistic, aggravated by totally new supply sources which must develop their own distribution channels;
- a rising interest in protectionism in the United States.

North American agriculture is itself in a period of major structural change. Grain producers are facing a very competitive market as a result of increasing exports from the European Economic Community, Argentina and Aus-

tralia. Meanwhile, countries that used to be major importers, such as India and China, no longer require grain because of the success of their own agricultural policies and could, in fact, become an export threat. The result is a flattening out and perhaps even a drop in grain trade while more suppliers become a factor.

Domestically, a switch away from beef, veal and pork consumption toward poultry and fish means weaker demand.

Weak prices and volumes, coupled with a high debt structure from investments in farm assets at inflated prices, have meant that net farm income, as well as gross income, has dropped dramatically from the 1970s. Uncertainty surrounds the nature of U.S. farm support programs which have become a costly drain on the treasury without producing the healthy farm economy which was their objective. Indications are that a large percentage of farms in the USA will go bankrupt and that perhaps 20 to 30 percent of land will be taken out of production.

The United States accounts for 55 to 60 percent of Saskatchewan potash sales and the Saskatchewan industry has about 75 percent of the market. This potash is used largely to grow corn and soybeans. Fertilizer consumption is likely to drop at least 5 percent with zero growth for several years even though more productive land will be farmed more intensively. Without unforeseen events, U.S. potash consumption, which represents 95 percent of North American consumption, is likely to plateau and unlikely to recover to the record of 1979 until the middle of 1995.

Offshore, the situation is varied although only slightly more optimistic. Western Europe is a mature market likely to show little overall growth. Eastern Europe has more growth potential but is unavailable to non-East European producers because of the production in East Germany and the USSR, both of which are net exporters to most markets available to other producers. Africa is unlikely to provide much in the way of growth because of political instability and lack of strong agricultural development policies in most areas. Oceania is a small market and its technology is well developed so that a small growth rate will have little impact on volume.

That leaves Latin American and Asia as the major growth areas. Cuba and Brazil are the major markets in Latin America. Cuba is largely locked into East European suppliers. Brazil represents about 65 percent of the market in this region and has good growth potential. Consumption grew quickly in the late 1970s, but the debt crisis brought this to a halt in 1980. A major drop in consumption took place between 1981 and 1983, with some recovery

in 1984 and 1985. A new potash mine will eventually meet some of their own requirements. It remains a very competitive market, with GDR being the base supplier through bilateral trading relationships and favourable financing. Growth in Brazil could be in the order of 8 percent per annum with perhaps 6.5 percent for the region as a whole during the next decade. Its financial problems have not yet been totally resolved.

The other growth market is Asia. India has emerged as the largest market and the country with the most stable growth rate. Japan is a stable market, but it has no growth potential because its agriculture is likely the most intensive in the world.

China appears to have the largest volume potential of any country in Asia. While its apparent consumption rivaled India's in 1984, it has yet to become a steady growth market as its purchasing pattern over the last decade has been very erratic. For example, it purchased most of its needs from Canada in 1984 with some 700,000 tonnes KCl. In 1985 it has not purchased anything. Considering that such a sale represents a 65-percent operating rate for a typical Saskatchewan mine, China's absence as a buyer is significant. Other markets in Asia with growth potential include Indonesia, South Korea, Malaysia and the Philippines. As a whole, Asia should grow at 4.5 percent per annum during the next decade, recognizing that the overall growth rate will depend on China.

The debt crisis and lack of foreign exchange facing some of the countries in Latin America and Asia have forced them to adjust their agricultural policies negatively, as well as reduce purchases except under the most favourable financing terms or countertrade.

Countertrade can take place in several ways. It can be conducted under a bilateral trade agreement between countries, a method which has been used by East Germany; through tenders involving both purchase and sale of commodities, as has been the case with Indonesia; or it could be a preference for suppliers that purchase quantities of the buying country's goods, as recently introduced by India. Regardless of the mechanics, it is a growing factor in world trade.

One of the problems which has been a continuous issue since the mid 1960s is oversupply created by expansion of the world industry based on forecasts which have always been too optimistic. Hopes for the Green Revolution, which led to the potash oversupply of the 1960s, never materialized and the capacity installed was not utilized until the late 1970s. Expansion plans initiated during the latter

period, coupled with a drastic cutback in demand estimates for the 1980s following the recession, mean that the industry will be in a serious state of oversupply until at least the early 1990s. If new supply sources now planned in some of the developing countries as well as Manitoba, New Brunswick and Michigan proceed, the oversupply situation will continue well into the 1990s.

A review of world supply/demand estimates suggests caution in basing expansion plans on estimates more than five years into the future (figure 2). There is no historical basis to believe they will be anything but optimistic. Indeed, the FAO/World Bank Working Group estimates, which form the basis for many forecasts, should be regarded as optimistic by definition, given that their objective is to ensure adequate supplies of fertilizer are available to maximize world food production.

Once new supply sources are on stream they remain there until costs cannot be recovered over a period of time. The length of this period will depend on the financial resources of the owner and its view of the future. As a large proportion of the world potash industry is state owned, the timing of closure can be further complicated and is difficult to predict. New supply sources in the current environment will also have a destablizing effect on prices.

Protectionism in the USA is also a threat to free trade in potash. The U.S. producers in New Mexico, with ore deposits and costs higher than those experienced by some other producers, have been under pressure since the mid-1960s. Several producers have closed or cut back operations and today production is about one-half that in the early 1960s. During the last year, all of the operations except one have been available for sale or have changed ownership, a clear indication that their current or previous owners do not anticipate improvements in the future.

This threat to the U.S. industry has resulted in a number of initiatives designed to delay closures or protect the remaining industry. These steps include attempts by ad hoc committees organized by the City of Carlsbad, New Mexico to investigate possible action that might be taken; Congressional public hearings chaired by Senator Domenici of New Mexico; and petitions to the U.S. Department of Commerce and International Trade Commission by two Carlsbad area producers for imposition of anti-dumping and countervailing duties against potash from Spain, GDR, USSR and Israel. While the results of these actions so far have been minimal, they, along with similar attitudes by the USA toward other imported commodities, suggest yet another risk for the world potash industry.

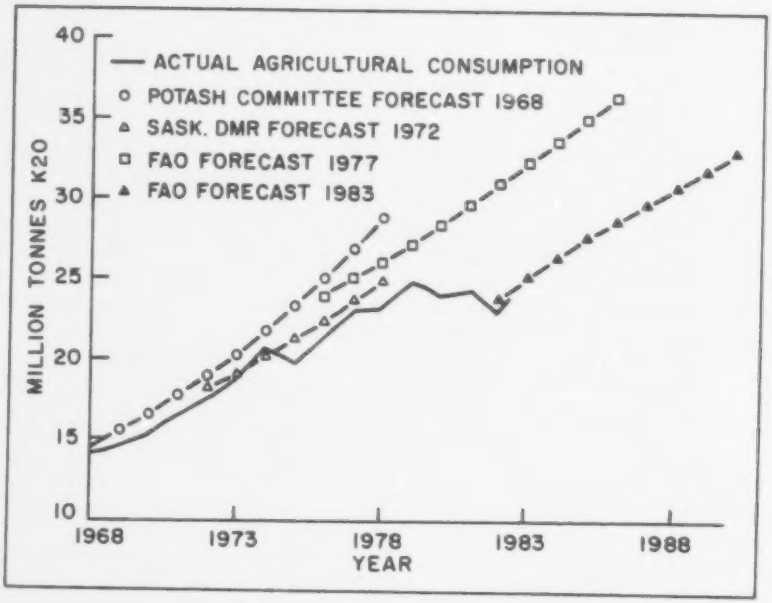

Figure 2. Forecast vs. Actual Potash Consumption, 1968-90

Conclusions

A number of conclusions can be drawn from a review of the present situation.

1. The potash industry will be forced to rationalize or close production capacity to deal with the overcapacity. This should be the high cost producers, but may not be because of protection provided.

2. Until rationalization of production takes place, weak prices will prevail. North American prices in current dollars are as low today as they were during the mid-1970s. Producers outside of North America are benefiting from a strong U.S. dollar which is insulating them from a cost squeeze.

3. Potash demand will again fall short of current estimates of expected demand (figure 3). A demand growth rate for the next ten years of 2 percent per annum is probably realistic. The period of oversupply therefore will be longer than anticipated.

4. The world industry will be under extreme pressure to reduce costs. New suppliers will find entry into the market difficult even if they can meet the unlikely criteria of accessible, high quality reserves, superior technology and close proximity to growth markets. This last condition is very significant because potash is a low-value bulk commodity for which transportation can make up as much as half the delivered cost. A look at freight rates and FOB mine netbacks in Canada suggests that railways have been much more successful at maintaining a price structure to recover increasing costs than has the industry (figure 4). Freight costs must be kept low to maintain a competitive industry.

5. The potash industry in Saskatchewan has the ability to expand its capacity at one half to two-thirds of the cost of a large greenfields project with less lead time. When capacity is required, it can be added at most of the operations in the province in small increments. New technology will enhance this ability. New potash projects, at least in Canada, cannot be justified in the foreseeable future on a normal rate of return basis.

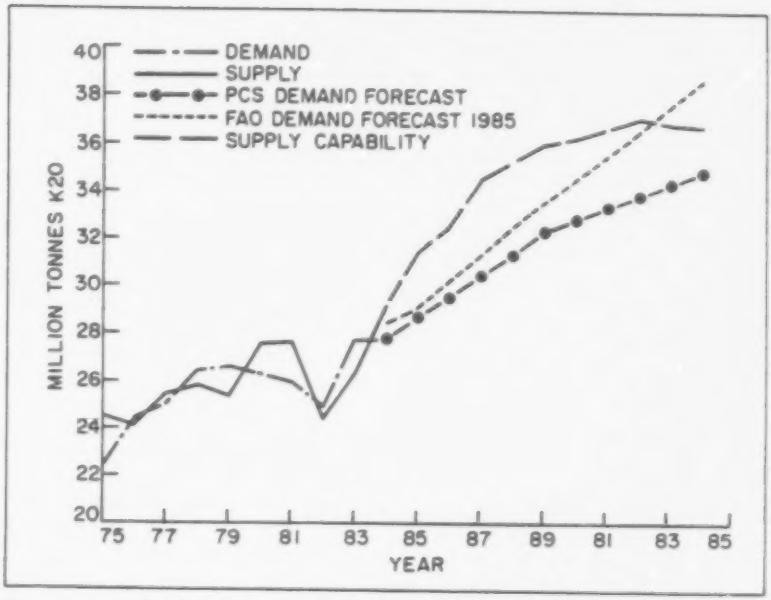

Figure 3. World Supply and Demand, 1975-95

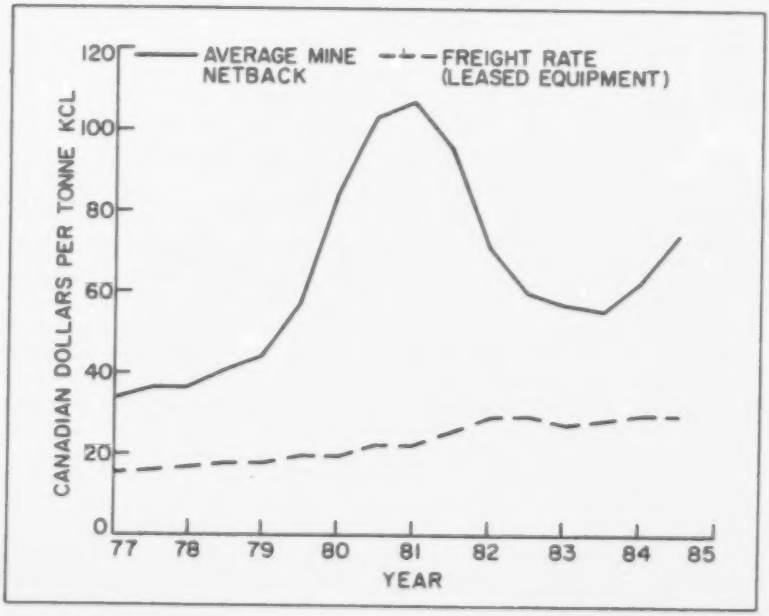

Figure 4. Saskatchewan Export Netbacks vs Freight Rates to Vancouver, 1977-85

6. The new economic environment means the Canadian industry must learn to compete more aggressively in the global market. New markets must be developed and serviced. For example, this may mean that countertrade will become an increasing part of conducting business. CIDA funding has been of great assistance in developing markets in India, Sri Lanka and Indonesia. CIDA's participation in an agronomic development program jointly with the Government of Saskatchewan and the industry to demonstrate the benefits of potash in China will ultimately result in more consumption. Such funding must be continued.

   Saskatchewan potash is sold offshore through a producer-owned company called Canpotex Limited which provides good sales and transportation economics to the industry. To survive and grow this company must be aggressive in its sales program and accommodate the more complex environment of the present. A customer's needs must be met. The alternative is not to be in business.

7. Finally, governments must be careful not to place too many demands on the industry for economic rent. At least in Saskatchewan, these expectations have always been high. A number of economists have attempted to determine whether the rent has been maximized.[6] While the debate is interesting and the revenues raised have been substantial, the possible negative implications for the long-term health of the industry and growth potential cannot be overlooked. It may be that the payments extracted are too high and that as a result jobs and investment are lost.

In summary, the world potash industry is at the beginning of a fourth period of structural change since its beginning. The industry, at least in North America, is presently having difficulties. With a more aggressive marketing effort, some attention to the errors of the past and a strong program for R&D and development, it will emerge stronger. This is particularly true for Saskatchewan which has the reserves to meet demand for at least a thousand years.

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6. David L. Anderson, Discussion Paper No. 264, The Saskatchewan Potash Industry: Alternative Strategies for Future Development, Economic Council of Canada (Ottawa 1984).

THE IMPACT OF TRADE POLICIES ON CANADIAN MINERALS

Germain Denis

Before narrowing the focus down to minerals, it is worth taking a little time, I think, to set trade policy into a more general Canadian perspective. The bottom line is that trade and trade policy have contributed significantly to Canada's development as a nation and to the evolution of our economy into one which is modern, diversified and well integrated into the world scene.

The Role of Trade Policy

Throughout the post-war period, Canada's trade policy has been consistently oriented toward seeking improved access to larger markets for Canadian goods and services. This, in turn, has encouraged a substantial degree of international specialization and provided for a more competitive and stimulating environment within the Canadian market. Overall, as a fall-out from Canada's participation in seven post-war rounds of trade negotiations under the General Agreement on Tariffs and Trade (GATT) and various other initiatives, Canadian producers now benefit from very significant opportunities to increase their productivity through sales, not only in the relatively limited Canadian market, but also in the USA, Japan, the European Community and the rest of the markets of the world.

But trade policy is not simply a matter of opening up markets to the freer flow of goods and services. However important that aspect may remain, trade policy plays other roles. Market access, once achieved, needs to be secured or safeguarded. The GATT itself plays a very significant role in this regard, as do the various nontariff barrier agreements negotiated under GATT auspices. Bilateral trade relations and initiatives that enhance them are also important players. An effective trade policy also looks at ways of improving the functioning of the international marketplace, and of dealing with any distortions to competition which may exist or arise. Finally - and of periodic direct relevance to metals and mineral producers - trade policy considerations play a significant role in the regulation of either injurious imports or strategic/sensitive exports.

The Significance of Resource Sectors to Canadian Trade Policy

Exploitation and transformation of the products of Canada's resource base - whether the sea, the soil, the forests or the mines - has consistently been a foundation for industrial development. The development of export markets has been a priority concern over the years in the conduct of Canada's trade relations with many other parts of the world, but especially the USA, Japan and Western Europe.

This is particularly the case for ores, metals and the processed or fabricated products of our mineral endowment. The strong export orientation of the metals and minerals industry in Canada has meant that, along with agriculture, fisheries and forest products, the resource-based sectors have had a determinate influence on Canada's position in trade negotiations in particular, and trade policy approaches more generally.

Canada remains among the world's largest exporters of aluminum, nickel, zinc, asbestos, molybdenum, gypsum and platinum. Exports of metals and minerals still exceed 20 percent of total Canadian exports; Canada also imports important quantities of minerals such as bauxite, coal and iron ore for use in the iron, steel and aluminum smelting industries.

Something in excess of 80 percent of these Canadian mineral exports is in the form of crude materials and primary metals, and it is not surprising that industrial diversification and development aspirations of various regions and communities across the country are tied to the prospects of raising the level of production of these resources in Canada.

The 1960s and 70s saw an erosion of Canada's overall share of several world mineral commodity markets. Through the 1980s the supply/demand balances may begin to be restored as economic recovery occurs, but slower international rates of economic growth seem to hold the promise of only modest growth of world consumption of metals and minerals.

Canadian producers can nevertheless be expected to remain a major factor in international mineral commodity markets, particularly for nickel, copper, zinc and aluminum. Similarly, Canada may be expected to become an important factor in the world thermal coal market.

Canada's favourable resource base and reputation as a politically stable and reliable supplier of resource commodities should serve Canadian producers well in maintaining their shares of world markets. Moreover, although overall world supplies for major minerals may be relatively abund-

ant in present economic circumstances, major industrialized countries remain heavily dependent on imports of industrial raw materials and concerned about ensuring stability and security of their supplies.

During the 1973-79 Tokyo Round of multilateral trade negotiations, metal and mineral products received high priority attention from Canadian negotiators. The results, while perhaps less far reaching than had been hoped at the outset, were nevertheless a very considerable accomplishment. Overall, looking at the average for all major industrialized countries (Canada included), the tariff rates on metal semi-fabs, for instance, were negotiated downward by about 30 percent. Coupled with similar results from previous negotiating rounds, this means that such rates now average below 5 percent. For articles of metal, the average residual protection in industrialized countries is now around 6 percent, down from almost 10 percent at the start of the Tokyo Round. There was also some success registered in bringing nontariff measures under better discipline and in reducing or eliminating their impacts.

Just as averages and generalities mask the reality of a particular duty rate which stands as a barrier to shipments of a particular product, so some of the specific accomplishments of past negotiations fade into the recesses of memory. People forget, for instance, that an important reason behind Canadian ores, concentrates, potash, sulphur, and many fertilizers moving essentially unimpeded by tariff barriers is that duty-free access was bought and paid for in the course of earlier negotiations. It is, I think, also worth recalling some of the specific concessions agreed upon during the Tokyo Round and right now in the final stages of being implemented. The U.S. rate on aluminum ingot, for instance, was negotiated to "free". The USA also agreed to cut its tariffs on most asbestos products to "free". Its rate on magnesium ingot, 20 percent at the outset, will reach 8 percent after the end of next year. The tariff on the main manufacture of gypsum (i.e., wallboard) was also agreed to be cut by 60 percent and will be less than 2.5 percent after the end of next year. The USA also agreed to reductions in the area of 40 to 50 percent for such semi-manufactures as pipe, bar, rod, plate, sheet, etc., most of which will face duties in the 4 to 7 percent range after the end of next year. There were also some less striking reductions agreed to by the European Community and Japan. Canadian exporters of semifabricated nickel, aluminum and copper products to Europe will now face duties in the 4.5 to 10 percent range, down from the 6

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Queen's University Kingston, Ontario

Structural Changes in the World Mineral Industry: Implications for Canada

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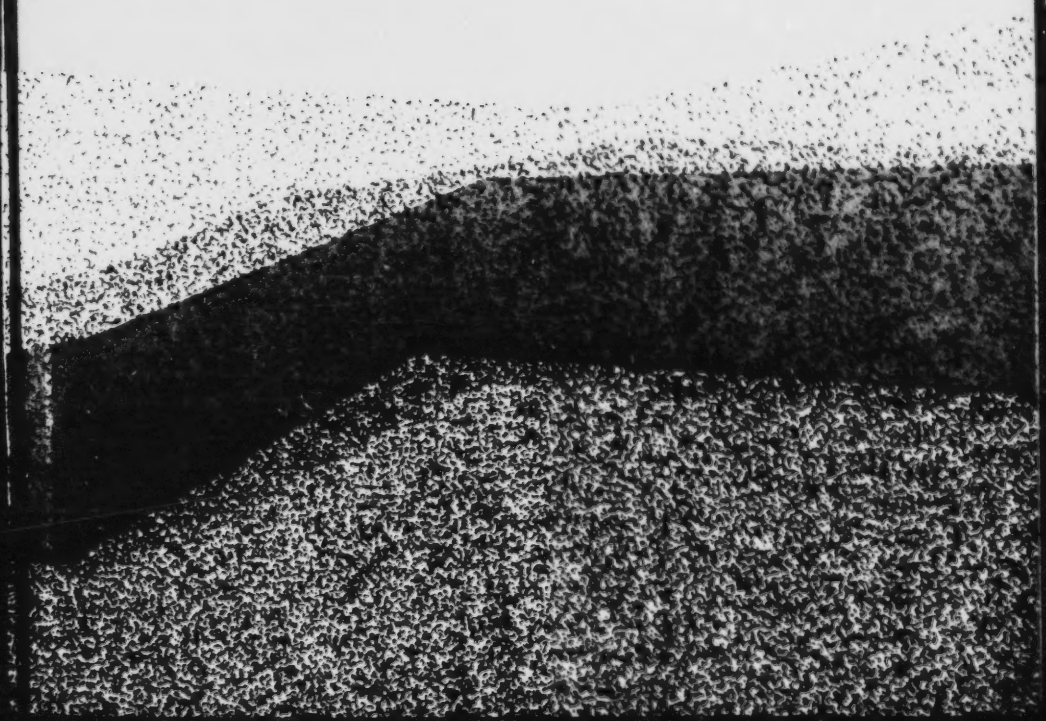
M.J. WOJCIECHOWSKI



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FOREWORD

This volume contains the proceedings of the 15th CRS Policy Discussion Seminar. The CRS seminar series brings together individuals from industry, governments, labour, universities, and other organizations to share their knowledge and views on selected issues in mineral policy.

Structural changes over the last decade or so have profoundly and permanently changed both supply and demand patterns in world mineral markets. The seminar looked at these changing patterns, both in general and for several specific commodities, discussed related economic, trade and currency-related issues, and identified strategic responses which have been taken and might be taken in future to assist the Canadian mineral industry in adjusting to the new circumstances.

The seminar was held at the Donald Gordon Centre for Continuing Education in Kingston on September 9-11, 1985. The program was arranged by Peter Richardson of Queen's University School of Business, in consultation with CRS. The proceedings volume was edited by Margot Wojciechowski and produced by Donna Beaubien.

The Centre is grateful for the contributions of the speakers and participants, both during the seminar and in the preparation of the proceedings. Views expressed are those of individual participants, and do not necessarily represent the views of the Centre or its sponsors.

Margot J. Wojciechowski
Centre for Resource Studies

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STRUCTURAL CHANGES: IMPLICATIONS FOR CANADA

Major changes have taken place in the structure of the world's mineral industries which have significant implications for the mining industry in Canada. While there is considerable work in process to measure these changes and understand their impact, the problem is far from being well understood. The purpose of this CRS Policy Discussion Seminar was to further understanding of the process which is under way, and develop policy recommendations which will enable Canada to meet the challenges effectively and to take advantage of opportunities arising from these changes.

Papers and discussions in the first part of the seminar dealt with changing patterns of supply and demand. Demand for many minerals is being affected by declining growth rates in existing markets and substitution by new materials. New markets, often with substantially different requirements and product characteristics, are emerging. Accompanying these demand changes are altered patterns of supply. Structural shifts are taking place in the world mineral industry which challenge Canada's position as a leading producer of many mineral products. Case studies of lead and zinc as well as potash cite specific industry examples of these challenges and their impact.

The structure of Canada's mining industry in the future will be, to a great extent, determined by the general economic climate. In the second part of the seminar, papers were presented addressing the general economic outlook for mining, trade policy, and the impact on the industry of currency fluctuations. In the United States, these factors have combined to play a key part in the recent decline of the mining industry in that country. Given the high export orientation of Canada's mining industry, these factors will play a key role in determining its future structure and share of world mineral trade.

The final part of the seminar presented alternative views of what actions might be taken to adapt to these structural changes. Papers were presented by federal and provincial governments, as well as private sector representatives. In addition participants brought forward their own experiences and views in a final plenary session and throughout the seminar, and these are restructured and summarized in the digest of discussions. A closing summary was provided by Keith Buck, former Secretary-General of the International Lead and Zinc Study Group, who has had substantial practical experience in dealing with structural change in this key industry.

KEYNOTE ADDRESS: STRUCTURAL CHANGES IN THE WORLD MINERAL INDUSTRY: IMPLICATIONS FOR CANADA

Phillip Crowson

Introduction

It is worth starting with a question of semantics: what, precisely, is meant by structural change? The phrase is often used to distinguish some kinds of change from the cyclical developments which are regarded as reversible features of the business cycle. Does this mean that we are discussing changes which are likely to prove permanent? Some changes which have been treated as structural will in time be reversed, so that we may be merely talking of long-run rather than short-run cyclical movements. Of course, a terminally ill patient, as much of the mining industry presently seems to be, may not be too interested to know that his condition is only temporary, when its conclusion is likely to be his demise. Yet we have to recognize that mining has always been a dynamic industry, as the grassed-over spoil heaps and ghost towns of abandoned mining areas throughout the world bear witness. Change has always been a feature of the mining business. Economists distinguish between cyclical and secular trends, the latter being defined as "those continuing over vast periods of time". Many of the recent changes in the mining industry, which have been described as structural are in truth secular. Other changes which may have appeared to be very sudden may not be genuinely structural in nature.

These questions, which could be multiplied almost ad infinitum, are highly relevant to this seminar. A failure to diagnose changes correctly may well lead to faulty prescriptions. In any case, this paper will concentrate on structural changes in the world mining industry rather than on their implications for Canada. Perhaps these implications can be summed up very briefly in Adam Smith's remarks over two centuries ago about the world always beating a path to the door of the man who builds a better mousetrap.

The roots of the mining industry's present difficulties lie in the extraordinarily sustained post war economic boom. This historically atypical period of 25 years of rapid economic growth without serious cyclical disturbances engendered firmly held beliefs about the inevitability of

progress. Exchange rates were reasonably stable under the Bretton Woods System, and world trade flourished as the controls of the 1930s and 1940s were progressively dismantled. An entire generation of managers and officials grew up who had never experienced different economic conditions. Investment plans were formulated in the confident expectation of continued growth, virtually underwritten by governmental policies. There might be the occasional pause but it would be only temporary, and it would be relatively easy to pass on cost increases in higher prices.

The devaluation of the U.S. dollar in 1971, the cyclical excesses of 1972-74 and the rise in oil prices associated with the Yom Kippur war severely dented expectations but did not dispel them. It was recognized that the world economy had suffered a series of shocks, and that growth might be temporarily delayed, but it was widely believed that normal service would be resumed relatively quickly. The last decade has seen harsh reality intrude on those illusions, which no doubt most of us shared in varying degrees.

Demand for Metals

Much has been written on some of the changes on the demand side of the minerals industry, but the comment appears to concentrate on the symptoms rather than the causes. Thus falling "intensity of use" is trotted out with monotonous regularity, and to the point where even Australian cabinet ministers can authoritatively quote the Japanese phrase "Kei Haku Tan Sho", or "lighter, thinner, shorter, smaller". It bears repeating that intensities of use of most metals have fallen in the developed countries for many years. Recent experience is by no means out of step with historical trends. Consider copper, for instance. Particularly in the United States there is some evidence of cyclical variation around a generally declining trend; a trend that has been in existence for many years. Other metals, by and large, show similar patterns.

By themselves, studies of intensity of use are descriptive rather than diagnostic. It is therefore worth going behind the figures in more detail. One of the major statistical weaknesses of the worldwide minerals industry now arises. This is the lack of regular, accurate and comprehensive data on the ultimate end uses of the individual metals. Without such data it is difficult to track exactly how demand has moved in the past and how it might change in the future. Table 1 is based solely on some fairly rough and ready estimates for the United States.

Table 1

UNITED STATES' DOMESTIC CONSUMPTION OF METALS BY END USE 1979 & 1984
(percentages)

	Aluminium		Copper[a]		Iron & Steel		Lead		Nickel		Zinc	
	1979	1984	1979	1984	1979	1984	1979	1984	1979	1984	1979	1984
Building & construction	24	18	18	34	27	31	3	3	9	10	40	45
Electrical	11	9	58	24			2	2	13	11	12	9
Machinery & equipment			9	16	20	19			7	7	10	11
Transport	22	20	9	12	31	27	73	75	24	24	26	25
Consumer durables	8	8				7			7	8		
Packaging	23	35			6							
Other uses	12	10	6	14	16	16	22	20	40	40	12	10
Total Consumption '000 tonnes	5,341	5,330	2,433	2,100	121.6[b]	99.3[b]	1,259	1,030	205	204	929	1,030

Source: Mineral Commodity Summaries 1980 and 1985.
Note: blanks denote no information given and included in other uses.
[a] Definitions apparently altered between 1979 and 1984, with the electrical demand being re-allocated in 1984.
[b] million tonnes.

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These are not entirely representative of the world as a whole, but they do bring out some important points. Demand for lead is dominated by the transport sector specifically for batteries and gasoline additives. Transport is also a major consumer of the other metals, except copper. Demand for aluminium is biased towards consumption, more so in the USA where packaging outlets are more important than elsewhere. Capital expenditure is the main determinant of demand for copper, iron and steel, and zinc, and probably of nickel were the allocation of end uses carried out properly. This dependence on investment and the transport sector provides a structural explanation of changes in demand for metals, an explanation that is more intellectually coherent than the sudden change in consumers' behaviour implied by many of the arguments about substitution and miniaturization.

The Behaviour of Investment

Here we enter another statistical minefield, in that few comprehensive historical data are regularly published on total capital expenditure, let alone forecasts. The main economic consulting firms often do not give figures for individual countries, let alone totals. It is clear that expenditure on investment has lagged behind consumer spending in the past decade, and that it has accounted for a diminishing portion of the OECD's total gross domestic product. Figure 1 compares the behaviour of real GDP and investment (gross fixed capital formation) in the OECD Area since 1970.

The latter's share of GDP dropped to 19.7 percent in 1983, the lowest overall share for at least twenty years. The fall was especially pronounced in the United States.

Going beyond the totals gives the picture shown in figure 2. Remember that building and construction figure prominently as major outlets for several metals.

Full details of 1984's spending are not yet available, except for residential construction. Expenditure on machinery and equipment, which includes vehicles of all types, is much higher now than in the early 1970s' boom. Much of this spending has been on cost cutting of all types and on enhancing productivity rather than on expanding capacity. In short, it has gone into equipment with high value added rather than into metals-intensive plant. The contrast with spending on construction, and especially on the nonresidential variety, is marked. These have clearly suffered from the slowdown of economic growth since the early 1970s.

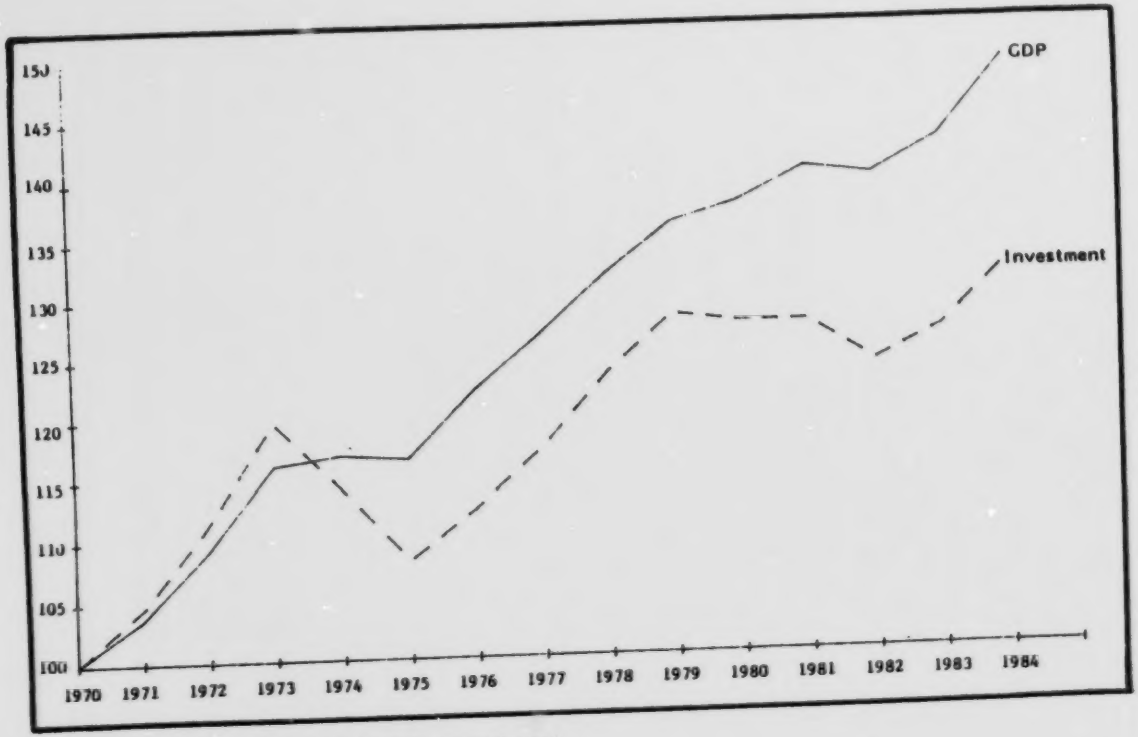

Figure 1. OECD Real GDP and Investment (index numbers 1970=100)

Source: OECD Historical Statistics 1960-83

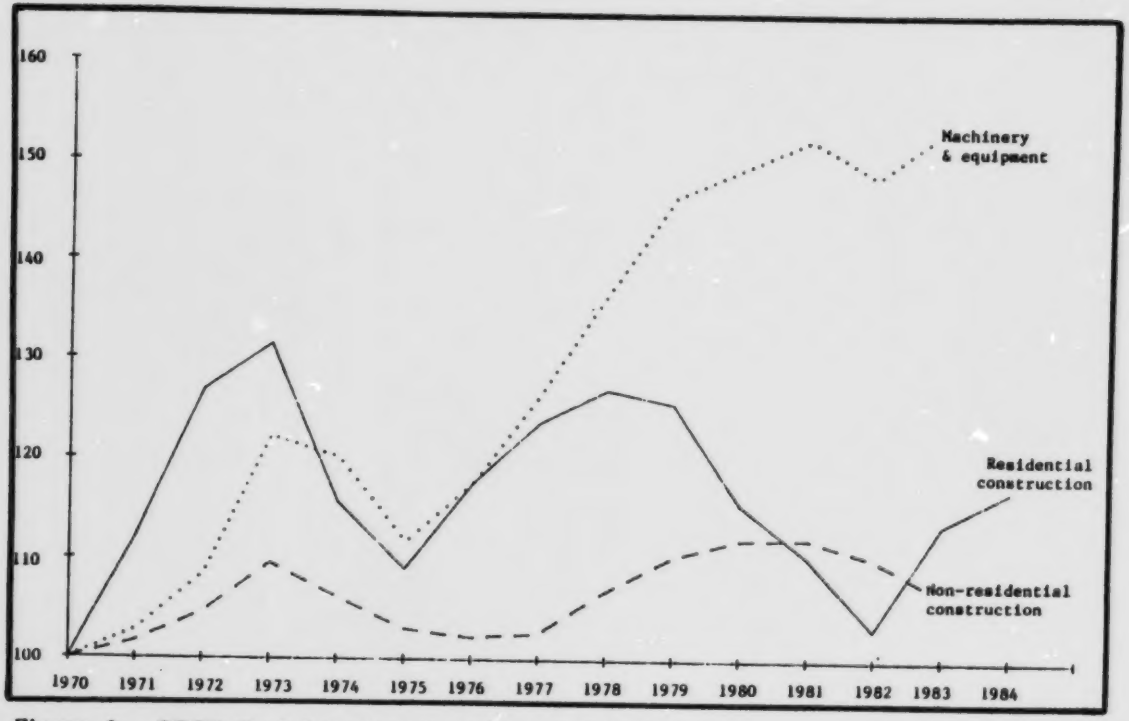

Figure 2. OECD Real Investment by Type of Asset (index numbers 1970=100)
Source: OECD Historical Statistics 1960-83

Over the 1960-83 period, nonresidential construction made up 36 percent and residential construction 25 percent of total OECD fixed investment.

Table 2 summarizes the slowdown in capital expenditure compared with total real GDP since the 1960s, and, for good measure, includes figures for industrial production and automobile output.

Table 2

OECD AREA GROWTH RATES 1960-83

	1960-68	1968-73	1973-79	1979-83
Gross domestic product	5.1	4.8	2.7	1.2
Industrial production	6.3	5.5	2.1	-0.4
Gross fixed capital formation	6.5	5.9	1.1	-0.3
of which:				
Residential construction	5.7	6.5	-0.8	-2.5
Nonresidential construction	6.5	3.9	0.1	-0.8
Machinery & equipment	7.3	7.6	3.0	1.2
Automobile Production	6.5	5.7	0.2	-1.0

Sources: OECD & IMF Statistics.

The addition of figures for 1984 would not materially alter the conclusions that can be drawn. A goodly part of the declining intensity of use of metals is closely related to the relatively poor performance of the sectors to which metals are sold. The question then arises as to whether these weak performances are irreversible. Logic, quite apart from the deteriorating state of the infrastructure on both sides of the Atlantic and Pacific, suggests that they are not. To some extent they are yet one more manifestation of the excess, or wrongly located, capacity engendered by a sudden and unpredicted change in the rate of economic growth, and by marked shifts in relative costs. The mineral industry's customers have been as affected by these factors as the industry itself.

Steps and Slopes

Strangely enough, its sectoral composition has not figured prominently in most explanations of recent trends in demand for metals. Instead, attention is concentrated on accelerated technological change; on the rapid spread of computer aided design in all its ramifications, and on the development of new materials and more precise manufacturing techniques. Intensity of use may have fallen in the past, runs the argument, but "you ain't seen nuttin yet" (to quote an ungrammatical utterance of the U.S. President). All is clearly not for the best in the best of all possible worlds, but is it really a Panglossian view of the future to suggest that such apocalyptic forecasts for the older metals are somewhat overdone? The burden of proof surely lies on those who make them, and they tend to forget that the effective diffusion of technical change is a much more protracted affair than the initial innovation. In short, substitution will lurch somewhat unpredictably, much as it has done in the past, rather than in leaps and bounds.

More ephemeral influences have also been at work on demand for metals in recent years. These are mainly linked with the re-emergence, albeit at historically high levels, of the norm of positive real interest rates in North America and the United Kingdom. Coupled with greatly reduced inflationary expectations, such rates have virtually eliminated speculative demands for metals, and have encouraged the liquidation of non-trade stocks. Consumer preferences have decisively switched from materials to financial assets. Genuine users have also pared their stocks to the bone, assisted in this regard by even more sophisticated computer-based techniques of inventory management. These reductions in inventories throughout the production and distribution chain are once-for-all steps. Now that they have occurred they should theoretically have no further influence on demand. That remains to be seen in practice. It is one thing to boast about just-in-time inventory policies when supplies are plentiful and prices weak, but quite another when there is no spare material available to keep the presses running even for ready money. Furthermore, an overall reduction of pipeline stocks reduces the timelags between changes in final demand and in requirements for raw materials, and increases the system's capacity for short-run surges in demand. The aluminium industry was caught by such a surge in 1983-84.

Excess Capacity

The inevitable counterpart of the slackened growth of demand for primary metal coinciding with long lead times for investment has been a general persistence of excess capacity. This was compounded by a general failure to recognize that the mining industry faced something more than a severe and prolonged cyclical downturn. The easiest route to cost cutting in order to sustain profitability in the late 1970s and very early 1980s was to expand, which further compounded the overall problems. The desires of raw material producing countries to upgrade their raw materials and of consuming countries to establish their own plants rather than rely on imports worsened the surplus at the processing stage. Figures 3 and 4 show the trends since 1972 in the amount of mine capacity in operation, and in its utilization for four base metals. Capacities, always fairly imprecise if only because of changing ore grades, have been calculated on a consistent basis throughout. Mines which remain shut for an entire year are not included in that year's capacity, and this gives an upward bias to the utilization rates in the later years. Figures 3 and 4 look at copper and nickel, and figures 5 and 6 at lead and zinc.

It should be remembered that 1972's utilization rates were depressed by a recession which may seem mild in retrospect, but which appeared fairly severe at the time. Each metal naturally has its own idiosyncracies. Nickel has occasionally been affected by lengthy strikes, and primary lead mines are partly governed by demand for silver and zinc and partly cushioned by varying production of secondary metal. Figures 3-6 demonstrate the persistence of excess capacity since the 1973-74 boom. This excess was worsened by increases in the capacity of all metals except primary lead. The relative stagnation of the latter helps explain the boom in lead prices during the late 1970s.

Lest these four base metals are regarded as special cases, table 3 looks at a much broader spread of 45 minerals. It contains approximate measures of the Western World's degree of capacity utilization in the mid 1980s. The figures are fairly rough and ready because they are based on 1984's mine production and the U.S. Bureau of Mines' projections of capacity in 1985. Not all the new mines included in the latter will have materialized, and some existing mines may have been closed. Furthermore, many of the mines included will seldom, if ever, produce at their maximum nominal throughputs. Even with these very important qualifications, the table does give a useful snapshot of the general extent of surplus capacity in the mining industry.

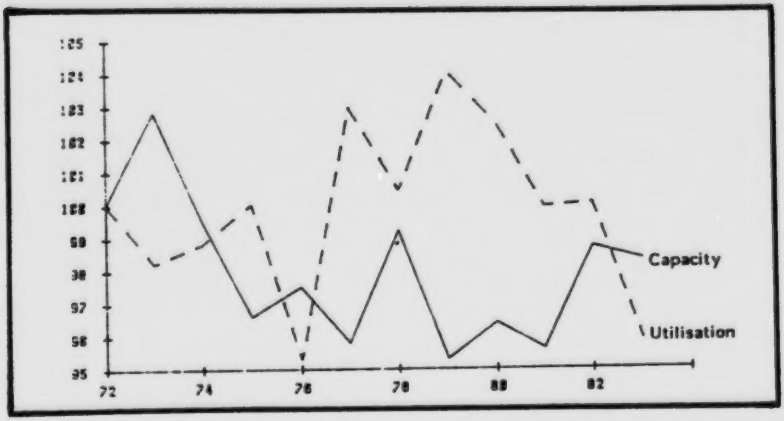

Figure 3. Mine Capacity and Utilization: Copper, 1972-83 (index numbers 1972=100)
Source: RTZ Mine Information Service

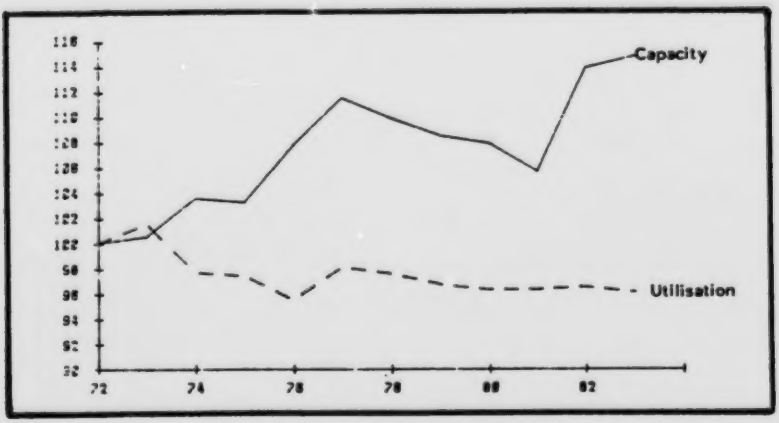

Figure 4. Mine Capacity and Utilization: Nickel, 1972-83 (index numbers 1972=100)
Source: RTZ Information Service

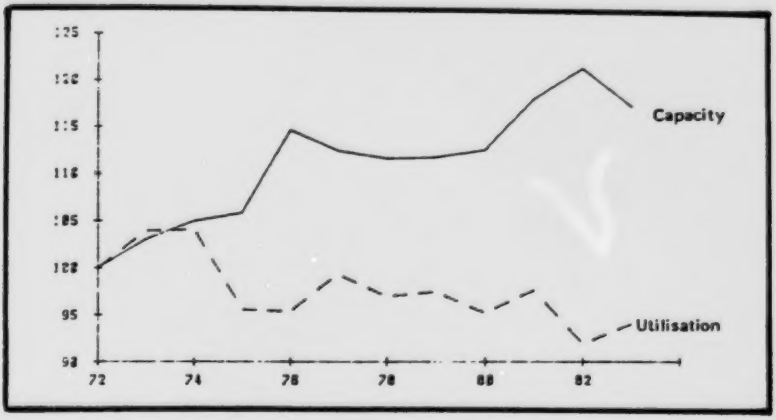

Figure 5. Mine Capacity and Utilization: Lead, 1972-83 (index numbers 1972=100)
Source: RTZ Mine Information Service

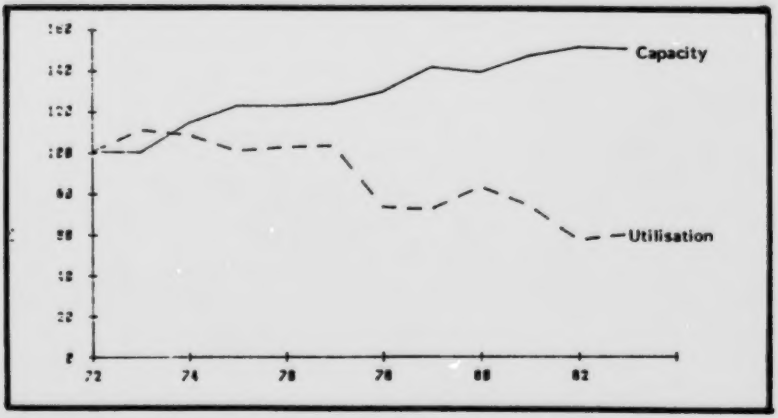

Figure 6. Mine Capacity and Utilization: Zinc, 1972-83 (index numbers 1972=100)
Source: RTZ Information Service

Table 3

WORLD CAPACITY UTILIZATION IN MINERALS: MID 1980s

Mineral		Capacity Utilization (percent)	Mineral		Capacity Utilization (percent)
Aluminium:	bauxite	56	Mercury		44
	alumina	64	Mica		47
	metal	63	Molybdenum		57
Antimony		59	Nickel		58
Arsenic		43	Niobium		47
Asbestos		60	Phosphate		79
Barytes		70	Platinum Group		77
Beryllium		27	Potash		76
Bismuth		58	Salt		73
Borates		60	Silver		82
Bromine		76	Strontium		86
Cadmium		58	Sulphur		67
Chromium		69	Tantalum		61
Cobalt		69	Thallium		68
Copper		68	Tin		70
Fluorine		65	Titanium:	ilmenite	62
Graphite		91		rutile	75
Gypsum		94	Tungsten		73
Iron Ore		54	Vanadium		46
Lead		72	Vermiculite		63
Lithium		57	Zinc		75
Magnesium		51	Zirconium		70
Manganese		66			

Sources: Capacity from Mineral Facts & Problems, 1980 Edition. USBM Circular 671.
Production from Mineral Commodity Summaries 1985. USBM.

Note: capacity utilization is shown as production in 1984 as % of estimated capacities in 1985. In most instances the percentages are based on mine output only.

Some Effects of Excess Capacity

Many of the mineral industries' present problems flow directly from the persistence of surplus productive capacity for so long. Whether or not that is a structural change is somewhat debatable, as it carries the seeds of its own elimination. In some minerals the restoration of supply and demand equilibrium is well advanced, whereas in others it started later and has much further to go.

The main effects of excess capacity have been twofold. First, the previous close link between prices and costs has been broken. This is best demonstrated by figure 7, which is by now probably fairly well known. It shows copper costs and prices annually since 1969.

Figure 7 compares average high and low LME copper prices with four points on the cumulative cost curve of copper mines for each year. The points are respectively 25 percent, 50 percent, 75 percent, and 90 percent along the curve of cumulative production. In previous years, when supply and demand were broadly balanced, prices tended to hover above the upper limit, which might loosely be defined as marginal costs, but in recent years they have dipped well down. The mining industry has responded with vigorous cost cutting programs, of both the "good", or permanent and of the "bad" or temporary variety. The mix between "good" and "bad" is an interesting question that will probably only be answered precisely with the passage of time. Either way, cost cutting has been insufficient to force the marginal costs of many minerals below prevailing market prices.

This is partly because of the second main effect of excess capacity: it has offered considerable scope for the expansion of spot and terminal markets of all forms. New entrants, and producers without forward linkages with customers, have resorted to traders and merchants to dispose of their output. These middlemen are more concerned with their margins than with the basic supply/demand balance. Also stocks have been amassed by producers, and merchants, some of whom may be constrained to sell by financial pressures. This rise in producers' stocks is a counterpart of the rundown of consumers' inventories already mentioned. Major producers have been unable to hold to cost-related list prices, and the consequences has been greater price volatility, and lower price levels relative to average costs.

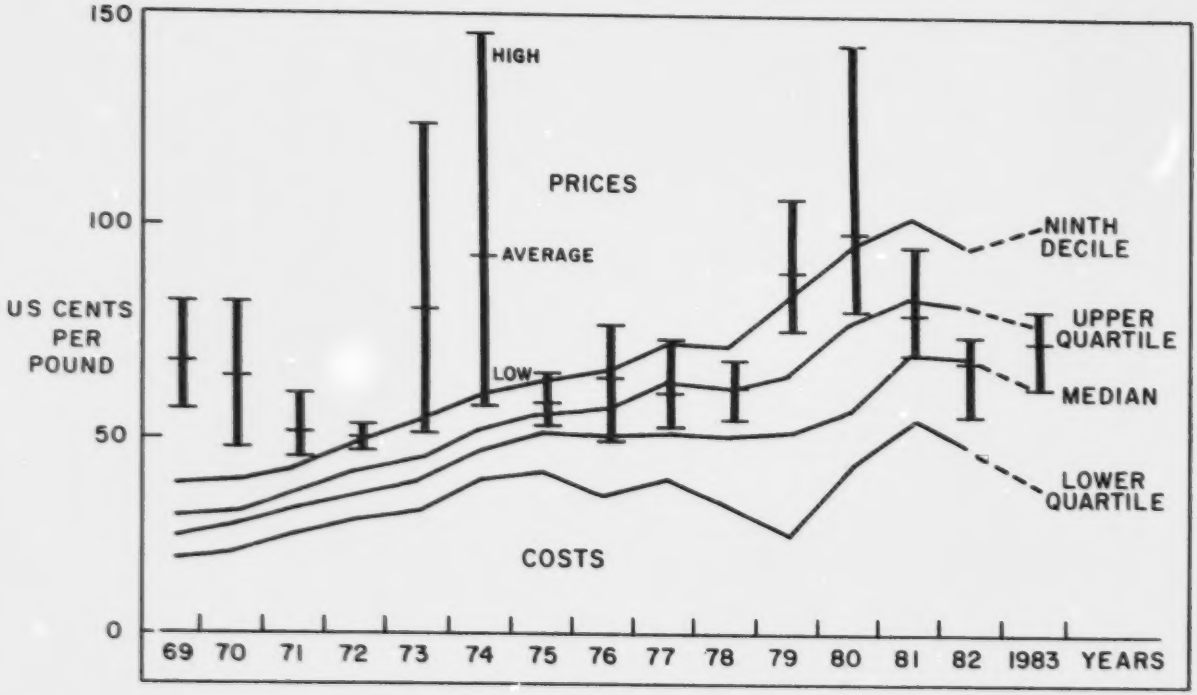

Figure 7. Cash Breakeven Costs and LME Prices of Copper, 1969-83 (U.S. cents per pound in money terms).

The Diffusion of Political and Economic Power

The weakened ability of major mineral producers to control their prices is one by-product of a genuine structural change over the past twenty years. This has been the diffusion of political and economic power away from North America and Western Europe. The rapid development of Japanese demand opened up sizeable new opportunities for Pacific Rim mineral producers in the 1960s and early 1970s, creating, for example, a market in copper concentrates. The more recent development of other South East Asian economies and of Latin America has further widened markets, incidentally increasing the scope for merchants.

More important, the decolonizations of the post war decades were followed by strong desires for economic independence to support political independence. Canadians do not need reminding that economic nationalism, particularly when concerned with resources, has not been confined to the developing countries. The wave of nationalizations of the late 1960s and early 1970s changed the mining industry's structure of ownership and weakened the hold of major international mining companies on world supply. Tax increases everywhere greatly lowered the mining companies' financial resilience in hard times. The successor companies, usually state owned or controlled, who have often made considerable contributions to additional capacity, have lacked marketing and financial expertise. Furthermore, they have perforce paid far more regard to national economic objectives than their predecessors. It is unclear whether the more recent temporary entry of the oil companies was, with apologies to Karl Marx, history repeating itself as tragedy or as farce. It probably depends on which side of the fence the spectator of that interesting episode in the mining industry's recent history was sitting. The oil companies have not been the only new entrants who have further spread the industry's ownership in recent years.

Much of the comment about the damaging effects of state ownership on the minerals industry has been marked by an almost complete absence of logical analysis. The main impact has been a diffusion of power and objectives on the producing side of the industry, and a further weakening of links between producers and the market.

Final Comments

The more usual complaint about state-controlled production is its inflexibility. That is merely one aspect of these

weakened links, and state-owned producers are by no means the only culprits. The conflict between the requirements of healthy mineral and metal markets on the one hand and the preservation of jobs and local incomes on the other is being fought throughout the world. All producing and consuming countries are in the long run best served by a healthy and efficient minerals industry whose worldwide supply and demand are in broad dynamic balance. Unfortunately, measures being taken in many countries, and not least in some Canadian provinces, are deferring the restoration of that balance. Where such measures are a response to genuinely temporary adverse factors, they may be justified. It is, however, better to act directly on the basic causes of imbalance, such as an over-valued currency, than on the symptoms, such as uncompetitive mines. Subsidies and temporary reductions in the prices of inputs merely transfer the mining sector's burdens to someone else. Herein lies the perennial dilemma of the mining industry; individual survival may be at the expense of prolonging the overall imbalance. Yet that imbalance is gradually being righted, and the survivors can look forward to a reasonably healthy old age.

CHANGING DEMAND PATTERNS:
Panel Discussion

William G. Deeks

Change is all around us. This is particularly so for the business of producing and selling metals and minerals for end-use markets. Historic change has always been viewed as cyclical change, and we are probably still in a cyclical pattern but the time frame from the beginning to the end of the cycle has been considerably extended. In addition to cyclical change, however, we are also seeing the effects of structural change. A definition for structural change is change taking place which is permanent and probably not reversible.

Examples of structural change include: competition from production in structured economies; the economic impact of changing currency values; the competitive thrust from new man-made materials; the impact of design changes, particularly for consumer durable products making the use of traditional materials obsolete, changing growth patterns in markets related to affluence and population growth; and changing consumer expenditure priorities. Collectively, all these changes are having a profound and negative impact on the economics of the mineral industry, especially in North America. Intensive competition has been created for markets, partly between producers in different economies with different currencies and partly between materials themselves.

Historic ideas of value are being challenged. What is the right price for a commodity today? Does it link to historical trends, or is it, in essence, facing a new set of realities in terms of value opposite substitute materials? Everywhere one looks, production costs have to be reduced in dollar-based economies in order to compete with lower wages and currency values from other countries. Are jobs in our society worth today what they were worth 10 years ago? What will happen to the level of wage rates in traditional U.S. and Canadian industrial centres compared to the willingness of people to work for much less in other countries and even the southern United States? Have some sectors of our industry been burdened with taxes and other costs related to working with government which are eroding their competitive ability? Are there environmental burdens placed on the production of metals and minerals in Canada and the United States which cannot be borne and, there-

fore, are the forerunner of a noncompetitive and closed down industry? These are all questions we have to focus on now.

Searching for answers is frustrating, as there do not seem to be many readily available ones. Obviously, one of the answers to the problems being faced by the mining and metallurgical industry is to put a great deal more effort into product research and market development. Along with this needed commitment, there is also the need for continuing effort in improving production systems in a push for much higher productivity and, finally, real emphasis on the need for impeccable product quality.

As well, new initiatives in the visibility and transparency of the industry are required. Noranda has been a strong advocate of the merits of study groups on an international basis to provide a forum where the problems and opportunities for a particular commodity can be reviewed by the major participants and their governments in the hope that more sensible business decisions will result. This should lead to an enhanced industry with a deep commitment for product research and market development, rather than a depressed industry with no funds to protect itself.

Overall, our belief is that, as never before, the industry must become market driven. By market driven, one means an industry that is concentrating on customers and what customers expect from it.

The GM Saturn program is a really good example of a major change taking place in the manufacture of a world-class competitive small sized automobile in the USA. Saturn will be seeking to cut the cost of making cars in North America in half, and will be striving to accomplish this through a high degree of automation, rigid inventory control, new assembly and component manufacturing systems, faultless performance of parts at all times, efficient use of materials, elimination of scrap, and employment of the kanban concept.

Kanban originates in Japan and is the practice of a Japanese housewife to indicate to her baker that she needs another loaf of bread by putting a small wooden disc in a wicker basket outside her door. This truly is "just-in-time delivery" of a needed product to do a specific job. The housewife's inventory control procedure is through the use of the wooden disc which triggers the delivery to provide the bread she needs to feed her family at that moment. Industrially, the kanban concept embodies statistical process control to assure a quality driven production system and just-in-time delivery to ensure direct shipment of components onto an assembly system without the need to hold wasteful inventories and all the double handling that goes with it.

Saturn and kanban are simply a reflection of the way things are heading, and if they are heading that way in the motor vehicle industry, eventually all manufacturing operations will be faced with the same need for productivity gains, modernization of processing facilities, better manufacturing assembly systems, computer controlled and organized flow of materials and very much higher-quality standards.

These concepts present some formidable challenges for Canadians. For many of our metal and mineral businesses, the Canadian market is too small to justify the kind of investment needed to provide the state-of-the-art facilities necessary to be competitive. The answer for Canada has to lie in much greater access to the U.S. market. It is only with that access that large segments of the Canadian manufacturing industry are going to be able to justify the capital needed to improve their facilities in order to be competitive.

The irony is that we really have no choice, because if we do not modernize and become competitive, Canadian manufacturers will slowly go out of business as their products are replaced with products made elsewhere, quite possibly in the Pacific. Already there are small manufacturing enterprises in Ontario shifting their production to the Pacific and using their Canadian operation as an assembler and distributor. It is time we focused on what is happening to these basic core manufacturing enterprises in the Canadian economy. We cannot afford to have our basic production systems move offshore. We cannot survive as a service country without the wealth creation that goes with an active and expanding mining and metallurgical industry on the one hand and a manufacturing and processing industry on the other.

Part of the hurdle we have to cross in facing the competitive reality of the future is the use of computers in the management of our business. Modern state-of-the-art manufacturing and assembly processes are heavily linked to computer systems. Computers monitor the performance of equipment, providing exactly the right characteristics to produce a predictable high-quality part. Other computer-driven machines finish and prepare parts for final assembly. Even more sophisticated machines have the ability to sight, through laser technology, the different configurations coming down an assembly line and then to program the action at each station automatically, exactly conforming to the particular component approaching.

The guesswork is being taken out of the production process. Manufacture proceeds on the basis of known data

and predictable machine action. No longer is it feasible for one man to operate one machine. Now it is more likely that one man will operate ten machines, and work from a computer console.

The hurdle of moving into electronic management is both a knowledge and a culture shock, and it cannot be done by chance or happenstance. Introduction of electronic management systems into an enterprise must be carefully planned, with good orientation and training programs for the people involved. It is absolutely essential that it have support from owners and senior managers in order that the people involved realize the fundamental commitment of the enterprise to change which is necessary. A major focus on manufacturing in Canada with this perspective is required today.

To summarize, there is no question that we are being buffeted by the forces of change today. Answers to our problems lie in increased and serious commitment to research and development at both the processing and the marketing stages of our industry. Access to the U.S. market is vital to expand our market base in order to justify the capital needed to upgrade our facilities. Competition is severe and will continue to be so, in many cases arising in structured economies with premium domestic markets protected from imports and juicy incentives for exports. It is absolutely necessary that Canadians understand the competitive trade environment in which we are competing, so that appropriate actions can be taken in Canada to counter the destructive impact of such subsidized activity.

CHANGING DEMAND PATTERNS:
Panel discussion

George A. Jewett

The essence of structural change today is that competition is forcing industry to achieve major improvements in productivity, product quality, and performance. Industrial society experiences change of this magnitude only when technology offers the possibility of significant increases in efficiency, such as those offered by steam power and Henry Ford's production lines. Materials technology is the moving force this time. The momentum of such structural change is a flood tide, which benefits us all, if we can learn to swim.

This time, major technological developments in biology, information processing, and production technology are happening concurrently. All will have dramatic effects on society, for the better. Materials technology is almost certainly the most significant science of our age. In its own right, it makes cheaper, more reliable and higher performance possible. In addition, new materials developed by materials scientists make the advances of the other technologies possible.

Remember - the only reason Leonardo da Vinci designs did not "fly" was lack of appropriate materials. Science is now able to respond with materials to meet the needs of any innovator today. New competitors with new rules are attacking metal markets with innovative products developed in their research labs.

A common objective in industry today is higher quality, but at the same price. To compete, suppliers must improve quality and meet the market's demands or else they will witness diminishing sales. Quality can be improved either by increasing specifications, or by achieving more consistent performance by narrowing tolerances. There is another way: by ensuring that the user is taking full advantage of the properties of metals in his design and manufacturing.

Most manufacturing in metal in North America is based on outdated technology and substandard quality control, and as a consequence, overdesign is common. The result is loss of competitive advantage. The copper radiator is a case of a market that need not have been lost, because a competitor introduced new manufacturing technology, and better quality control. If the copper industry had been

there first (and it could have been) a 50,000-ton market could have been preserved. Of course such activity goes beyond the industry's traditional view of "selling".

The Oxford English Dictionary defines the verb to sell as follows:

- to dispose of in exchange for money;
- to keep stock of for sale;
- to be a dealer in;
- to prostitute for money or other consideration;
- to make a matter of corrupt bargaining;
- to find purchasers.

The plastics industry uses the last concept; the metal industry, the first three, although there are some who suggest that numbers four and five have been widely practiced in the metal trade in recent years. Polymers have achieved their greatest market penetration in replacing metals, and this trend is projected to continue for at least ten years. The loss in metal markets could exceed one million tons in aggregate over this period.

Polmer producers have expanded their markets by first analyzing the market opportunities carefully and correctly. They did this ten years ago. They then produced products to meet specific market requirements. Next, they developed efficient and cost-effective production processes for the user, and gave them to him. Engineering plastics commonly replace metals on a one-to-one basis, by volume, and commonly achieve weight savings of 50 percent - often because of overdesign in metals, and inefficient manufacturing metal technology.

The success of engineering polymers in replacing metals can be attributed to a variety of factors. Among the most important are cost savings and weight savings. While the raw material cost of even the most inexpensive engineering polymers exceeds that of metals, the plastic materials offer economies in processing and fabrication. Engineering polymers may be injection molded with significantly lower energy consumption and at faster production rates than die casting, the similar processing technique for metals. Many plastic moldings require no post-mold finishing, while metal castings and stampings must often be polished, deburred and cleaned.

Engineering polymers are particularly adaptable to production of multifunctional, single-piece assemblies. For example, an injection-molded business-machine housing generally includes such features as mounting bosses, through holes, integral color, and functional indentations,

which are incorporated during the molding cycle. With sheet steel housings, the cabinet must be formed and painted, fasteners attached and through holes cut or punched in separate operations.

Over the last 10 years, the plastics industry has organized effectively to create markets for their products, in spite of inferior specifications and market resistance. If the metals industry is to maintain market share it must do the same; it must learn to "sell" its product against plastics and other competing materials. The metals industry must focus on the marketplace, must be positive and look forward instead of backwards (which is what we do when we look at traditional demand patterns). The industry must learn again how to create demand.

Post World War II was an exceptional period in history, a period of exceptional demand when, in the words of Peters and Waterman, "anyone could make money". No one likes to be diminished in quite that way, but what if it is true? What if the period can be shown to be an historical aberration, and that there have been only two other comparable periods of inflation, escalating demand, and general increase in expectations in all commodity markets, especially metals? If that is true then we can anticipate years of stable commodity prices - in a very competitive market.

A CRS seminar earlier this year concluded that "metal markets are extremely cyclical". Let us get the tense right - they "were" but are not now, and almost certainly will not be in the future. We can identify oversupply scenarios in virtually every metal forward for at least ten years. In addition there is a new factor in the equation - substitution. Substitution is an ever-present threat today with stable, depressed prices. If the price of any metal should escalate rapidly today, the market will switch to alternative materials within a matter of months, or weeks. In most cases the switch will be irreversible for many years, if ever. For this reason there will be a powerful counterpoise to demand pull in this marketplace for metals, which will tend to keep prices stable for many years. Consequently, we can look forward to fluctuating demand, perhaps, but stable prices.

This is not all bad - it certainly clears the mind and may even provide the basis for some sound long term strategic selling strategies within the metals industry.

CHANGING DEMAND PATTERNS:
Panel Discussion

Gordon R. Peeling and Winston Chambers

Change breeds apprehension. Apprehension affects expectations, and expectations influence the behaviour of industry, labour and government. Thus, any change which is perceived as a threat to the established economic, social and/or political order is usually destabilizing and, in consequence, costly.

Structural change, i.e. fundamental shifts in the relative importance of the principal sectors of the economy, is of that kind. It is a source of serious concern because of its possible adverse consequences. It could, and indeed it has, resulted in:

- heavy financial losses and even the demise of companies;
- considerable unemployment through the obsolescence of skills or through dramatic changes in the capital-labour ratios of new production systems.

But structural change is not all bad. Despite its adverse effects, it it necessary for economic growth and development, and as a growth factor it invariably affords opportunities. In a sense, structural change represents a kind of paradox. On the one hand, it creates many difficult economic problems; on the other hand, it offers novel opportunities for industrial development and expansion. In this paradox lies the formidable challenge of how best to exploit the opportunities afforded by structural change while minimizing the private and social costs of warranted structural adjustments.

This is the critical problem which industry, labour and government must address. It is not an easy problem. It cannot be resolved overnight, and the way in which it is resolved will be crucial for the future commercial viability of the industry as well as the industry's contribution to the Canadian economy. Thus the development of appropriate structural adjustment policies becomes all important. But what, one may ask, are appropriate adjustment policies?

This is a singularly important question for which there can be no absolute answer. This is so because the answer entails normative considerations: i.e. subjective consider-

ations of what ought to be. Not surprisingly, therefore, there are likely to be widely different perceptions of what, in a given situation, constitutes appropriate adjustment policies. None the less, the formulation of structural adjustment policies, however perceived, demands a good understanding of:

- the determinants or sources of the structural transformation we are now experiencing;
- the magnitude, extent and impact of the changes;
- the nature of the threats they pose;
- the opportunities they present;
- the options that are open to the mineral industry; options which must be considered with reference to certain constraints. Some of these constraints are the openness of the mineral sector, the market structure of the industry, (e.g. absence of monopoly power) and the mineral development and trade policies of competitors and trading partners.

Determinants or Sources of Change

Broadly speaking, structural change is the consequence of the interaction of a complex set of factors. It may be brought about by underlying trends in productivity, technological innovation, demand patterns, or trade flows.

Structural change in the mineral industry can be attributed mainly to four factors. These factors are:

- economic forces;
- scientific and technological imperatives;
- government policies and regulations;
- international institutional activities and arrangements (e.g. concessionary financing of mine development by international financial institutions).

These four factors - economic, scientific and technological, government, and international institutions - are not mutually exclusive. Their activities interact to effect far-reaching changes in both patterns of supply and demand for minerals.

Economic Forces

The increase in energy costs, occasioned by a series of oil price shocks and the attendant energy conservation drive,

greatly affected the volume and composition of mineral consumption, as well as the processing technology of energy intensive minerals.

The imperative of reducing energy consumption, or rather of reducing energy costs in industrial production, prompted design changes in the automobile, aerospace and other major fuel-consuming industries. Design changes emphasized weight reduction and improved energy efficiencies. This led to substitution among metals. It also increased the demand for plastics, composites and modern ceramics as replacements for metals in several design applications.

In a period of escalating energy costs, the use of a new class of plastic-based materials - called the composites - has much to commend it. Composites can be stronger then steel, lighter than aluminum, and more rigid than titanium. Graphite/epoxy composite has the same strength and rigidity of aluminum, but is about 40 percent lighter. These properties of the composite are clearly economically and technically desirable in designing for performance and fuel efficiency. This explains why major commercial jetliners like the Boeing 767 and 757, Douglas DC-10s, and Lockheed L1011s all use carbon/graphite composites in several secondary structures to eliminate upwards of 1200 pounds of structural weight.

Aside from energy costs, the necessity of having to remain highly cost-competitive has been a source of structural change. In periods of low economic growth rates, stagflation, or major cyclical contractions in economic activity, new technology may be introduced to reduce the unit cost of production. The introduction of robotics in mining, and the emergence of mini-steel mills are cases in point. They represent significant structural changes on the supply side.

Scientific and Technological Imperatives

Certain scientific advances and technological developments create a demand for new materials. These new materials are critical requirements for the development and operation of the new technology. This kind of material requirement is evidenced in aerospace, rocketry, information-communication networks, and in the use of lasers.

The aerospace industry's need for materials with high strength-to-weight ratios and improved thermal shock, dielectric, abrasive, and refractory properties initiated a considerable amount of research and development in cera-

mics during the last decade. Among the advanced ceramic materials which was produced during this period was silicon carbide. One of the hardest substances known to man, it is used extensively in the manufacture of rocket nozzles. Currently, it is also being used for critical-wear components for pumps, valves, compressors and other equipment used in energy and chemical process industries to control flows of gases, liquids and slurries.

This use as a critical-wear component makes silicon carbide a substitute for some metals. Similarly, new concepts in communications, such as the use of satellites, microwaves, and optical fibre, have threatened to displace copper in communications.

Government Policies

Government, through various policy initiatives, contributes to structural change. Defence, environmental protection, resource procurement, and trade and development policies all can, and do at times, induce structural change.

Much of the development in materials technology in the U.S. is defence related. Graphite epoxy composites are now extensively used in fighter aircraft; and a major development in the use of composites in helicopter airframes is now under way. The U.S. Army sponsors the Advanced Composite Airframe Program (ACAP) which is attempting to produce the technology needed for designing and manufacturing new helicopters with all-composite airframes.

NASA is another strong supporter of composites, as is evidenced by the use of 4000 pounds of the material on the shuttle orbiters. The 60-by-15-foot bay doors of the Columbia are made entirely of graphite composite, making the craft 2700 pounds lighter than if it were composed entirely of aluminum structures.

Governments, through their regulatory initiatives, can also restrict the use of certain materials for a variety of reasons. The impact of environmental pollution and health protection regulations on the use of lead and asbestos is now well known.

The resource procurement strategies of resource deficient industrialized economies can also effect structural changes on the supply side. Where resource deficient economies endeavour to diversify their sources of supply both to minimize supply disruptions and to improve their bargaining leverage, such policies sometimes lead to major supply/demand imbalances demanding structural adjustment on the supply side. Indeed, a major problem facing many

mineral commodities today is the existence of surplus production capacity.

These examples of structural change are disturbing. For some observers, they portend a sunset industry. For others, they present difficult problems and challenging opportunities. How damaging has structural change been for the industry? How much of a threat does it pose for the future commercial viability of the industry as a whole, or major segments thereof?

These are, for the most part, empirical questions. To answer them adequately we must resort to facts and figures. There is, however, a paucity of relevant data. The reasons for this lack of data are two-fold. Firstly, the structural transformation is still in progress. Secondly, the industry is still being adversely affected by the lagged impact of the last global economic recession.

Nature and Extent of Structural Change

The fact that the industry has been affected simultaneously by a structural transformation and a major cyclical contraction compounds the difficulty of specifying the magnitude of the impact of structural change per se upon the industry.

Notwithstanding all this, there is some telling evidence of structural change. The lead industry provides a good example. Historically, lead has two major end-uses. The first of these was the lead-acid battery, which accounted for over 60 percent of total annual lead consumption. The second important end-use was as an additive to gasoline. Automobile emission control requirements and the development of new battery systems have seriously eroded the rate of growth of lead consumption. To counter the declining demand for lead in traditional uses, lead chemicals have been developed for stabilizing asphalt against cracking. Roadways paved with this new asphalt are being tested in the USA.

This is all very interesting. But a knowledge of changing patterns of production and consumption of a commodity or set of commodities does not in itself provide a sound basis for examining the nature, extent and impact of structural change. To know where the industry as a whole stands, how it is adjusting, and how it should be adjusting to change, it is useful to examine structural change with reference to two things:

- intrasectoral shifts, or endogenous changes;
- intersectoral shifts, or exogenous changes.

Although these two categories of structural change are not mutually exclusive, their identification is analytically highly desirable.

It is not fully realized, for instance, that there are major intrasectoral shifts from metallic minerals to non-metallic mineral materials. Examples of this are found in the substitution of composites for aluminum, titanium and steel; ceramic magnets and electrical conductors for conventional alloys; and optical fibres for copper. A tremendous amount of research and development has been under way during the last decade in the field of ceramics. Ceramic materials, which include ceramic fuel elements, piezoelectric materials, glass ceramics, magnetic ceramics, nonlinear dielectric ceramics, cermets, dry-film lubricants, special glasses, ceramic composites and refractory ceramics, are all derivatives of industrial minerals.

Ceramic development is reaching realistic commercial stages, particularly in Japan which is leading the way. They have established government-coordinated industrial initiatives involving over 200 private companies to work toward such long-term objectives as the development of fully ceramic engines. These programs also contain many shorter-term objectives to produce such ceramic products as auto parts, knives, scissors, etc. These shorter-term objectives keep the R&D relevant to consumer needs. They also provide revenue from sales to pay for R&D, while creating consumer awareness of the actual and potential use of ceramics.

The Japanese approach differs markedly from those of the USA and U.K., which are largely defence driven. The advantages of low friction, high wear resistance, and high temperature resistance make ceramics a desirable material for high temperature engines, such as fighter aircraft and tanks.

Challenges & Response

How have these forces for change affected the demand for and supply of minerals and metals generally? What problems do they pose, and what's involved in responding appropriately?

Broadly speaking, structural change and an accompanying cyclical economic contraction have led to a marked decline in the rates of growth of mineral production and mineral consumption. This reduction in the rate of growth of mineral consumption has given rise to excess supply, under-utilized production capacity, intense competition for markets, depressed mineral commodity prices, shrunken

profit margins, capital losses and resurgence of protectionism.

These phenomena have posed and continue to pose a major challenge to the Canadian mineral industry. Simply stated, the challenge is how to gain access to and maintain an optimum share of emerging markets for minerals and mineral markets.

In addressing the topic "Response to Structural Change", the 1985 Mineral Outlook Conference advanced some policy presciptions. The Conference held that if the Canadian mineral industry is to effect appropriate structural adjustments then the industry should strive to:

- reduce the cost of production by improving technology and productivity;
- eliminate waste, emphasize quality, and develop measures that focus on long-range goals rather than short-term return on investment measures;
- listen to the market;
- support and direct product development and market-oriented applied research;
- continue exploring new ore bodies;
- develop commodity study groups to improve market transparency.

These are necessary conditions that must be met to be competitive, but they tell us nothing about the market itself.

An essential precondition for gaining market access and maintaining an optimum market share under changing conditions is to identify the market or markets in which we must compete. This requires us to ascertain:

- how the industrial structures of our major trading partners have changed and are still changing;
- how these changes have altered and are still altering traditional patterns of mineral materials demand. (This is, no doubt, what is involved in the expression "listening to the market".)

Once the emerging material requirements of our major trading partners are identified, then the structure of our mineral industry should be examined, to determine what changes, if any, are expedient if the industry is to respond profitably to the changing material requirements of a world economy in transition. This could be a rewarding exercise. It would indicate desirable structural developments; it would provide a framework for evaluating the efficacy of traditional mineral commodity arrangements; and it could influence intra-sectoral investment flows.

FUTURE SUPPLIES OF METALS: THE TRANSITION

Simon Hunt and Graham Haclin

Economic Cycles to the 1990s

Seeing so much turmoil in so many producing countries that are substantial suppliers of metals, we were tempted to entitle this paper "The Renaissance of Mining in Developed Countries". But in discussing the concept, we decided that, while it is possible to reach that conclusion, it is premature. Premature partly because such a reversal in the pattern of world mineral supplies would require, among other things, the full recognition of the cyclical nature of the mining industry by the host government, such as Canada, in devising a tax structure which recognized this fundamental of mining. But more of that later.

Today I would like to leave two main thoughts with you. Firstly, that the metals industry is in a transition period, adjusting from endemic surplus to healthy growth and profitability. Adjustments, however, whether structural or evolutionary, present challenges and opportunities; and mining is no exception.

Secondly, the mining industry needs to protect, nurture and develop its end use markets as a matter of urgent priority. Failure to do so, or to do so using the cabbage patch philosophy without regard to the overall benefit to the industry, will prevent this transition from being accomplished. Mines need markets just as markets need mines.

Mining is a microcosm of the world at large. When long-term capital investment falls, as in the last decade, intensity of use for many metals declines; and vice versa. Looking at future supplies in isolation is as much good as looking at a bull elephant at ten yards through a pair of binoculars: the result would reproduce only the painful experience of the last decade. Demand and supply are interdependent. So before discussing with you the patterns of supply, which we see developing, I would like to share with you briefly our views of the economic cycles which we see shaping the world to the mid 1990s. I do so not only because what happens at the macro-economic level will directly affect demand, but because these cycles will affect supplies and management philosophy towards investment or, indeed, disinvestment. Recent experience is nearly always a powerful influence on the formulation of corporate policy.

We expect that the next ten years will see three recovery periods and two recessions. The striking feature of the recovery in the United States so far has been the growing mountain of debt at all levels, mirrored by the explosion of credit. For instance, for 1984 as a whole, nominal gross national product in the USA grew by $360 billion, but total domestic indebtedness increased by $715 billion. Thus each dollar added to GNP required two dollars of additional debt, a ratio which soared to 3:1 in the fourth quarter.

The distinguishing characteristic of the U.S. recovery is that debt is outpacing everything else: GNP, money supply and income. To find anything comparable in peace time, we must go back to 1929 when the debt-to-GNP ratio was a little over 2:1.

Such an excessive increase in money and credit should create inflationary pressures. Yet on the surface, none is apparent, as supported by the evidence of the GNP deflator, oil and commodity prices. Yet beneath these broad aggregate numbers there are some disturbing signals. In effect, inflation is being pulled upwards by the credit expansion in those sectors of the economy that are sheltered from imports, such as government purchases of defence and nondefence goods, the services sector, and residential fixed investments. Conversely, inflation is being pulled down by the dollar's strength, with import penetration preventing U.S. manufacturers from raising prices.

But the important point is that:

> borrowing creates an inflationary excess of purchasing power whenever the lender believes that he has not lost control of the purchasing power he has lent out until the borrower pays him back, but can sell or pledge the borrower's note whenever he wants to do a little more spending himself,

as Ashley Bladen wrote recently.

Looking solely at price indices as an indicator of inflation in the USA may well be misleading, as Keynes admitted after the hyper-inflation in Germany:

> Anyone who looked only at the index of prices would see no reason to suspect any material degree of inflation; whilst anyone who looked only at the total volume of bank credit and the prices of common stocks would have been convinced of the presence of an inflation actual or

impending. For my part I took the view at the time that there was no inflation. Looking back, I believe that a genuine inflation developed some time between the end of 1927 and the summer of 1929.

Today the Federal Reserve is in a box that is tightening continuously. Policy formulation has to be directed towards maintaining, or at least trying to maintain, economic growth and preventing the insolvency of a number of institutions. At the same time the Federal Reserve does not want to reignite inflationary fears. Yet it is unable to lean against these fears aggressively because an increase in the cost of money would have dire consequences on the attitude of Third World debtors. Indeed there are ominious signs that a deterioration will occur in the coming months as these debtor nations are finding the social strains of continued austerity to be unacceptable.

It is against this background that we path our pattern of economic development to the mid 1990s. Timing is given as a guide to direction only, and not as a "given". If it were so, I would have no need to be here today!

Recovery Phase I. This will continue until June/July 1986 in the USA and end 1986 elsewhere. Late this year and in early 1986 economic growth will be surprisingly strong in the USA. Shoring up the Farm Credit System will require a large dose of fiscal and monetary stimulus, starting sometime in October. By year end a rising budget deficit and open monetization by the Federal Reserve will be evident. The dollar will fall, having first continued its recovery; base and precious metal prices will rise; and market perceptions and asset structuring will shift from a disinflationary environment towards inflation hedging.

In the second quarter of 1986 the Federal Reserve will be forced to lean heavily against these pressures. Base and precious metal prices should peak in Autumn 1986.

Recession I starts in the USA in August/September 1986 and the rest of Western World between December 1986 and March 1987. This recession may not be so severe as we earlier thought; the more prolonged recovery, higher inflation in 1986, and more patch work on LDC debt could further postpone the inevitable financial debacle.

Precious and base metal prices should reach their low point in July/August 1987.

Recovery 2 starts in the USA around October/November 1987 and elsewhere by spring 1988. This period is likely to be characterized by more severe inflation, by strong economic growth with base and precious metal prices

peaking in first quarter 1990 at levels beyond what we can contemplate today. For instance, one of my technical friends, who has been following these markets for as long as I am old, has a clear pattern of gold prices; each peak is six times the previous cycle's low price. Thus he maintains that $285/oz was the low to give a gold price in the first quarter of 1990 of $1710/oz! It is around this period that the financial system could come under its greatest strain.

Recession 2 starts soon after in Spring 1990, is deep, severe with a basic reform of the international monetary system a likely prospect. As a result, interest rates will plummet, inflation will be contained, and long-term borrowing costs will revert to the long-run average of around 2 percent in real terms.

Recovery 3 will start towards the end of 1991, resulting in durable growth characterized by capital investment, particularly in infrastructure, electrical generating and distributing capacity, and energy, reminiscent of the 1960s.

Such is a thumbnail sketch of what we see ahead. Against this background, I now turn to the changing supply and cost patterns of the industry, and to tax reforms, which are necessary in many developed countries.

Highlights of Host-Country Influences

Although as yet uncertain, there is evidence to suggest that during the next decade we may see a renaissance of the mining industry in the industrial world. Much will depend on the attitude of host governments, as I have suggested earlier, and will discuss later.

How can we suggest that mining in the industrial countries is undergoing recovery when all the evidence, for the past decade, suggests that the reverse is true? In developing countries, continued and more rapid devaluations, creating increased social tensions, rising inflation, shortages of capital and foreign exchange combined with declining ore reserves in a number of countries could bring this about. So let us look at a few countries briefly.

Zambia. Production decline is accelerating. The percentage of foreign exchange revenue now being returned to the mining industry has fallen to 19 percent, compared with ZCCM's stated minimum requirement of 42 percent. State mining tax, effectively a front-end royalty on production, has been doubled recently from 10 percent to 20 percent, putting a further squeeze on the hard-pressed copper industry. Morale at all levels is low. By the mid-1990s capacity will be below 400,000 tonnes.

Zaire. While Zaire has not recently been in the news, nevertheless the situation will always remain uncertain. Any disruption of its rail system to the South African port of East London would be disasterous because of the deterioration in the "national route" to Matadi.

Philippines. Despite the reactivation of Sipalay, based on Japanese finance, 9 mines remain closed in the Philippines, all having ceased production since 1981, representing a loss in copper capacity of some 45,000 t/a. Furthermore the two major producers, Atlas and Philex, are in trouble due to serious maintenance and operating problems brought about by the adoption of short-term expendiency measures, inadequate planning, insufficient investment and serious foreign exchange shortages. Couple this with the increasing political tension in the country, the future of the Filipino mining industry must now be questioned. Capacity will fall below 200,000 tonnes by the mid 1990s.

Peru. The well publicized political and financial problems of the country will make it difficult for the government or the mining industry to attract capital. Capacity is likely to remain at around current levels of 370,000 tonnes.

South Africa. The current difficulties facing the country include political problems arising from polarization of power and a government whose policies are not condoned by the outside world, as well as a large build-up of short-term debts.

Chile. The example of South Africa should not go unheeded for Chile. While copper production is never likely to be disrupted for long, political difficulties could surface over the next ten years, making investment there even more difficult. Nonetheless, unique projects, such as Escondida, will always eventually attract investment, probably with greater assistance from the international financial institutions.

The foregoing examples illustrate a fundamental change in the future supply pattern for certain metals. The timing element plus a combination of other factors point to future capacity limitations and a marked improvement in the balance between mine capacity and likely demand. By the early 1990s, and for intermittent periods before then, there is growing evidence to suggest that mine capacity utilization will be at a high level for some metals even assuming only modest growths in consumption. This appears to be true for copper and zinc, and, because of the decline in South African output, also gold.

The factors contributing to this change are:

i closures that have already taken place, coupled with the difficulties of reactivation with only modest gains in metal prices;

ii the over mining and high grading which have been forced on the industry due to weak metal prices, which will result in future grade declines, lower output and shortened economic lives for major mines;

iii the maturity of many mines, reflected in limited finite reserves, limited scope for incremental expansions, rising cost structure, and falling production;

iv price constraints, capital constraints, greater selectivity and a generally more conservative approach have led to delays and deferments of many new projects. The result has been a period when few new projects are coming on stream. This situation will continue for a further few years, and is in sharp contrast to the rapid expansion in capacity which took place in the 1960s and early 1970s which produced the severe supply-demand imbalance that has plagued the industry for almost a decade.

Let us examine, in a little more detail, some of the changes which are currently taking place and which will have a significant impact in the 1990s. In particular let us look at reserves, the maturity of many major mines, and mine closures.

Declining Ore Reserves

Paradoxically, while total world reserves of known mineral deposits have been rising rapidly, total world reserves of ore have declined. We must all remember that "ore" is an economic concept. Put simplistically, it is "mineral which can be mined and processed profitably". Thus, ore reserves are as much dependent on future metal price projections, capital investment, interest rates etc., as they are on the undoubted skills of the exploration geologist.

In the past five years, we have witnessed a rapid decline in the ore reserve base of many existing producers. This is attributed to the following reasons.

The Necessity to "High Grade" or "Over Mine"

This has been a legitimate and natural response to lower metal prices necessitating survival economics, namely "mining for cash". Nevertheless, a price has to be paid, either in the form of sharply reduced mine life, or the need for substantial capital injection. Typically, higher grade ores have been mined, thus appreciably lowering the remaining ore reserve grade, while long-term development has been kept to a minimum. The combination of sharply lower future grade trends and the need for substantial capital investment will inevitably jeopardize the future viability of the operation, in the absence of a substantial and sustained metal price improvement.

The Necessity to Reappraise Mining Schedules and to Raise Cut-Off Grades and/or to Reduce Stripping Ratios

Clearly, as economics change, mining operators have to reappraise their situation. Often this is a slow process. Mine closures can be categorized into two groups: first, those in which "ore reserves are depleted" and, secondly, those which have closed "due to low metal prices". Clearly, in both cases ore reserves by definition have been depleted. It has been suggested that reactivations of closed properties will inhibit metal price improvements. Although potential reactivations could have a modifying influence on metal prices in general, these mines need appreciably higher metal prices to justify the heavy capital investment necessary to bring them back on stream.

Maturing Mines

Mines, like humans, experience three phases during their life cycles; youth, middle age and maturity (not, I would add, to be confused with old age, which none of us experience!).

The youthful phase is characterized by expanding ore reserves and expanding production. A series of incremental expansions typically takes place, but the ore reserve base also increases despite rising output. In the middle phase, it becomes increasingly difficult to expand the ore reserve base. Furthermore, incremental expansion becomes necessary.

Nevertheless, most mining companies now accept that the future health of the metals industry depends on compet-

itive prices to ensure market growth. This lower price scenario must inevitably affect ore reserve calculations, leading to higher cut-off grades, lower stripping ratios, and modified mining schedules. We have recently witnessed a significant downward readjustment of ore reserves by many mining companies.

Mine Closure and Possible Reactivation

While uneconomic mines are not, by definition, mining ore, it is common to continue to refer to their mineral reserves as "ore reserves". However, once these operations have ceased production, it is reasonable to question whether the operation will be reactivated and consequently whether or not the mineral deposit should retain the status of an ore-body simply to compensate for declining ore grades. Finally, the mature mine is characterized by limited life, declining ore grades, and a whole list of adverse cost factors: e.g. deeper mining, extended haul distances, ventilation and pumping problems, temperature gradients, greater rock hardness and so on. In addition to cost pressures, declining ore reserves limit the scope for incremental expansion, thereby removing one means by which costs can be contained.

In both copper and zinc, the past five years have witnessed an unprecedented level of mine closures, particularly in North America. Taking copper as the example, some 920,000 tonnes of copper mine production has been closed in the past five years, based on production figures for 1980-81, as shown in table 1.

Table 1

COPPER

Country	Lost Production Capacity (t Cu in conc.)
USA	637,300
Canada	103,600
Philippines	39,000
Australia	25,000
Other	115,200
Total	920,600

As already outlined, high grading, over mining, limited stripping, reducing capital expenditure are all contributing to reduced mine life. Many of the world's major mines, developed in the 1950s and 1960s, will be reaching the end of their economic lives in the 1990s.

Again, taking copper as an example, the projected lost capacity, based on actual 1984/85 production rates, is shown to the year 2000. It amounts to a staggering 1.277 million tonnes, as shown in table 2.

Table 2

PROJECTED CLOSURES (1986-2000)

Country	Lost Production Capacity (t Cu in conc.)
USA	1,310,600
Canada	178,400
Philippines	202,000
Australia	45,000
Other	541,300
Total	1,277,300

These factors are illustrated vividly in the illustrations of future capacity for copper and gold. Although our detailed projections may be inaccurate in detail because we have used conservative assumptions, the trends they show must be taken seriously. Statistics, however, are like a bikini. What they reveal is suggestive but what they conceal is vital. The statistics given in these graphs are I believe enticing. What is concealed is the changes within and between operations: vital statistics seldom come for free!

Mine Capacity Trends - Copper

Figure 1 plots Brook Hunt's forecasts of western world copper mine capacity to beyond the year 2000. Obviously it is difficult, if not impossible to make any meaningful forecast beyond say 1995, as 10 years is sufficient time to discover, evaluate and develop currently unknown deposits. The

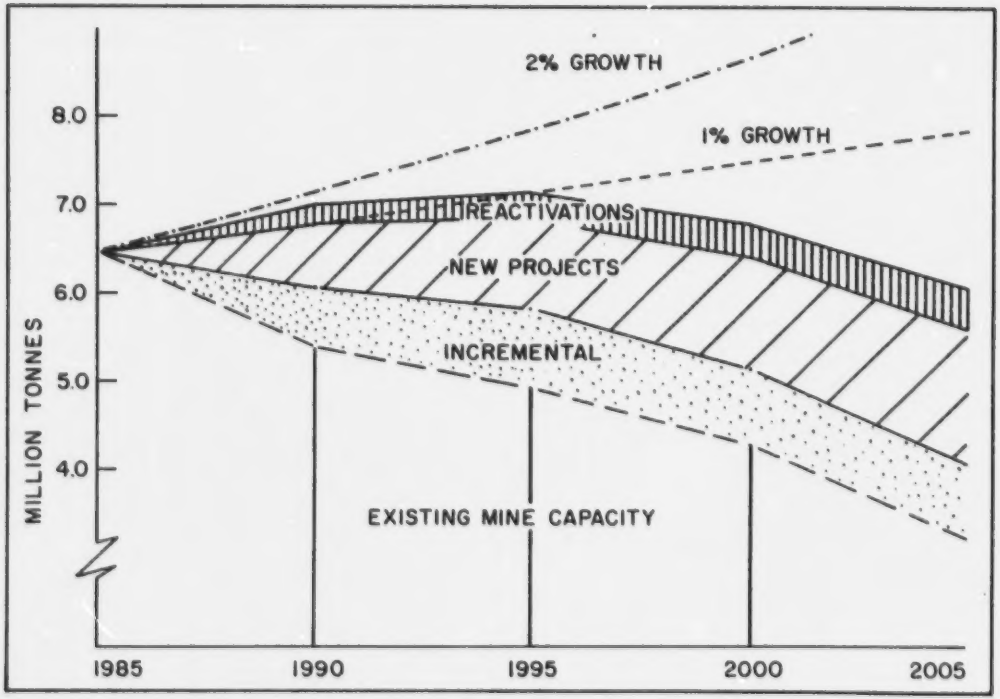

Figure 1. Copper Mine Capacity: Tightening Supply?

analysis to 1995 is done on a mine-by-mine, project-by-project basis and includes careful evaluation of future trends in the underlying cost parameters for existing and possible operations.

Despite the difficulties, we believe the underlying trend to be broadly accurate and certainly worthy of consideration. The figures show that, despite possible reactivations, the average growth in active mine capacity is unlikely to exceed one percent per annum. From figure 1 it is apparent that the main reason for this is the rapid decline in existing capacity. This is projected to fall from just under 6.5 million tonnes of copper currently to under 5.0 million tonnes by 1995.

Thus we are projecting that further closures, plus grade declines, and falling output etc. will reduce existing mine capacity by 1.5 million tonnes in a 10-year period. This is equivalent to a new Escondida every other year.

Clearly, incremental expansions partly offset this decline but, as already discussed, aging mines are less able to expand incrementally. Consequently, by the late 1980s or early 1990s the impact of incremental expansions will fade away appreciably. Our projections suggest that incremental expansions will raise existing capacity by some 800,000 to 900,000 tonnes of copper in the period to 1995, as shown in figure 1.

New projects are forecast to add 1 million tonnes copper to capacity and reactivations could add up to 400,000 tonnes, providing prices rise to levels which justify their reopening, i.e. well over 80c/lb.

Based on the foregoing projections, the net increase in western world mine capacity over the next 10 years is likely to a modest 700,000 tonnes of copper, representing an annual growth rate of only 1 percent. To achieve even this modest growth rate, a significant increase in price to around 80c/lb will be required to bring about reactivations and to encourage financial institutions to commit capital for new projects.

Clearly this suggests a much healthier market is in prospect. Furthermore, all else being equal, it points to a tightening supply situation.

We again stress that, although the detailed capacity projections may prove inaccurate, the overall aggregate picture is likely to be close to the eventual outcome. Certainly it is unlikely that the 1995 capacity projections could be understated by 10 percent and, as you will see from figure 1, this only raises the annual growth rate to just under 2 percent.

Taking a very conservative view of the figures, the conclusion is inescapable that the opportunity for growth and profits lies ahead for the industry. While the transition from a period of oversupply to potential shortage will not be smooth, it could occur more rapidly than anyone is currently prepared to forecast. Two assumptions, however, are built into these forecasts: first, that the mining industry does not repeat the mistakes of the last cycle. The projections assume that only robust, viable projects able to compete effectively within the current and future copper cost profile will be developed. Conversely, that the more marginal propositions are held back to await their slot in the long term demand curve. Second, the forecast assumes that copper prices will remain competitive with alternative industrial materials and that the industry will actively seek to promote copper to ensure it retains its existing markets.

South African Gold Production/Capacity

You will see that the gold data shown in figure 2 has been limited to South Africa. South Africa produces over 60 percent of western world gold, and over half of the total world output.

Two points need to be made before we look at the data presented. First, the graph assumes that production and capacity in a South African context are synonymous. Up to the present, South African mine capacity utilization has always been over 97 percent. Whether this can be maintained in the current difficult environment is an open question.

Secondly, our analysis for gold has deliberately been confined to South Africa. The country's production will continue to dominate world gold supply to beyond the year 2000. However, it must be remembered that, although South Africa has been an important gold producer since the early 19th century, its production is beginning to decline.

What will the trend be in the future? Figure 2 illustrates clearly the rapid decline in South African production beyond the year 1990. It shows also the potential dramatic fall in capacity beyond 1995. By the year 2000, based on Brook Hunt's independent and possibly controversial forecast, gold capacity in South Africa should fall to under 400 tonnes per annum, a decline of 45 percent on current output. The projections to the year 2000 may be in error, and certainly do not take into account the possibility, however remote, that a major new gold field could be discovered and developed in the intervening period.

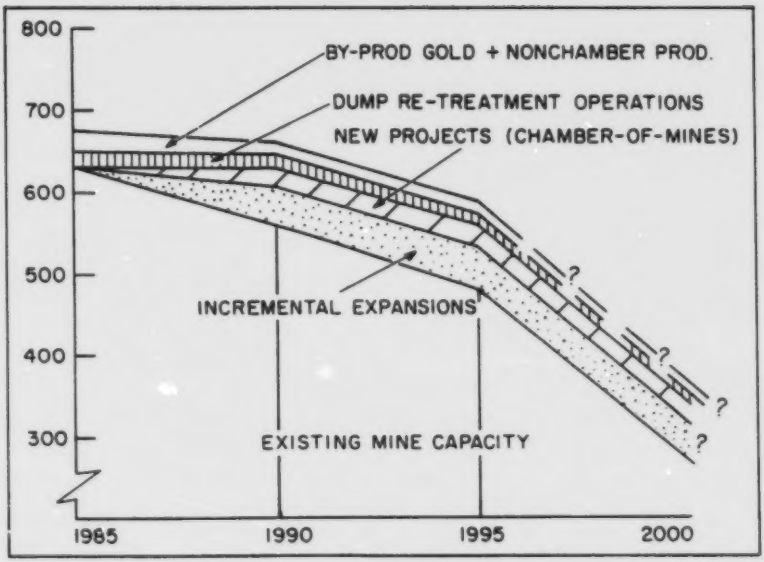

Figure 2. South African Gold Production Capacity: Major Decline Beyond 1990?

The more reliable projections to 1995 show clearly the drop in capacity. Existing Chamber of Mines operations have a current capacity of some 630 tonnes per annum of gold. Excluding incremental expansions and possible new projects, this existing capacity will fall to approximately 480 tonnes per annum by 1995. This rapid decline will be brought about by falling ore grades and mine closures (due to the exhaustion of reserves). Partly offsetting the fall will be incremental expansions which are forecast to add some 55 tonnes per annum and the development of totally new projects which could add a further 25 tonnes per annum.

Despite these important additions, total Chamber of Mines capacity is forecast to fall 11 percent to 560 tonnes per annum by 1995. Similarly total South African capacity is expected to drop from the current 675 tonnes per annum to 590 tonnes per annum by 1995, a decline of 12.5 percent. As figure 2 illustrates, the decline beyond 1995 accelerates rapidly. This trend of falling gold production in South Africa should offer exciting opportunities in other countries.

Production Costs

"In this world all achievements are transitory or at least fragile so we must look at the future", wrote Paul Johnson. And on this note it is important to look at the outlook for production costs. Production costs for most metals have declined substantially over the past four years, an obvious response to weak metal prices. It has been brought about partly by measures taken by the industry, helped appreciably by factors beyond the industry's control. The latter have included currency devaluations, lower energy costs, static or falling wage rates, and a general decline in the rate of inflation. The industry has made major improvements in its overall efficiency, with significant reductions in labour intensity and energy consumption, improvements in inventory and stores control, and so on. It has also been forced to adopt various short-term measures such as high grading, and cost deferments including reduced stripping rates and lower development expenditure.

It is interesting to reflect on the need for greater sophistication in competitive analysis within the metals industry. This is required not only by mining companies but increasingly by banks. Most senior executives in the industry recognize the importance of detailed cost analysis to assess their own competitive position, to evaluate poten-

tial new projects and to understand the overall trends in the industry world wide. At Brook Hunt we have recognized that this alone will not be enough in the future. Our analysis is being oriented increasingly towards a detailed assessment of the underlying cost parameters in order to make meaningful projections into the future. Feasibility studies will increasingly incorporate not only production costs, financial analysis, and environmental impact statements, but also assessments of other even more fundamental variables, such as relative energy intensity and labour intensity. Already the relative capital intensity of a project has become an important development criterion.

So what is the outlook for costs?

While it is probable that labour rates and energy prices will continue to fall marginally over the next few years, for the most part the metals industry faces a period of steadily rising costs, for the following reasons.

i Many operations world wide, faced with weak metal prices, adopted a survival mode with major cost deferments, particularly waste stripping, underground development and capital expenditures. Clearly, if these mines are not to close, a catch-up phase is inevitable.

ii Similarly survival has meant that most mines have been operating to maximize ore grade. Again a cost must be paid. In part this will be manifest by reduction in the economic life of the property, but in the short term more rapid grade declines can be expected with consequential impact on unit costs of the metal product.

iii The massive reductions in the labour force of the minerals industry have largely run their course. Although some minor improvements may be possible and some operations are still over-manned, in general, cost reduction by shedding labour will be difficult to achieve. Consequently, higher productivity will increasingly depend on innovation and capital investment.

iv In those countries which have enjoyed the short-term benefit of devaluations, rising domestic inflation will have an adverse impact on costs. In those countries where devaluation has become an on-going phenomenon, eventually devaluation and inflation go hand-in-hand with little or no impact on costs expressed in

U.S. dollars. For countries which have recently embarked on such a course, devaluations are clearly having an initial beneficial impact on costs, but inflation will rapidly erode this short-term advantage.

v As already discussed, many mines are entering a mature phase. These "old ladies" face rapidly deteriorating cost structures with limited scope for offsetting adverse cost trends by incremental expenses.

vi Another subtle long-term cost factor is arising from the problems being experienced by a number of major underground block-caving operators. With deeper mining, ores have become harder and their caving properties have declined, with the result that a number of mines face a difficult future, possibly having to modify their mining method appreciably with depth, resulting in substantial cost penalties with serious economic implications.

From our observations, mines and mining groups are falling into two distinct camps; those who have a clearly defined long-term strategy to continue reducing costs and improving efficiency, with any short-term measures fully integrated into this overall strategy; and, a second group who are increasingly living from day to day with little or no real grasp of how they will contain costs in the future. This latter group could become vulnerable if another economic downturn occurs in the next few years.

Short-term measures to reduce costs must not be introduced solely on the basis of pure expediency; they must form an integral part of an overall long-term cost reduction strategy. By this means, short-term measures need not be detrimental to the long-term viability of the operation.

A simple example is given. An open-pit operation with severe cost/price pressures was forced to revise long-term mining plans. As part of this revision, the ultimate pit was reduced in size with a consequent small decrease in total available ore. In addition, research had indicated that steeper pit walls were possible in certain sections of the mine and this was also incorporated into the revised plan. The net result was an appreciable reduction in the long-term stripping ratio. As part of an overall strategy it was decided to reduce waste removal immediately, with consequent improvements in mining costs. Crucially, however, this short-term advantage was viewed only as a respite. During the period of lower costs some of the spare equipment capacity was used to relocate future waste dumps,

appreciably reducing future waste haul distances. As a result, total mining costs continued to fall even though the stripping rate had to be steadily increased. We stress that the foregoing example is not intended to teach the obvious; it is presented only by way of illustration. The concept of a fully integrated strategy is a mark of good management.

One obvious result of the difficult period which has faced the industry is that it has focused attention on the absolute necessity for good management at all levels in the industry. It has also underlined the importance of good strategic planning, able to take full account of the cyclical nature of the metals industry. A key feature of such strategies is a rapid flexible response to changing circumstances.

Another aspect is that increasingly, prudent mining groups worldwide are facing the reality that it is not good enough to depend on metal price improvements to solve problems, the problems must be solved by steadily increasing productivity and efficiency. "Plan for low metal prices, hope for higher prices", should be the watchword.

Taxation Considerations

This leads us into the area of tax reform in developed countries which, if fulfilled, could help bring about a renaissance of mining in these countries. Mining can no longer be treated as the "milch cow", to be drained by windfall taxes every time the metal markets pick up and ignored when metal prices plummet and profits turn to losses. Sound policies are needed, based on the cyclical realities of the industry.

Throughout the developed world there is need for a unified sliding scale tax formula for the mining industry, on the lines of that applied to the gold mining industry in South Africa. This formula essentially incorporates two concepts:

- tax rates should vary depending on the level of annualized profitability;

- below a certain level of low profitability, tax becomes negative with a consequent tax rebate (state assistance).

This is illustrated in figure 3.

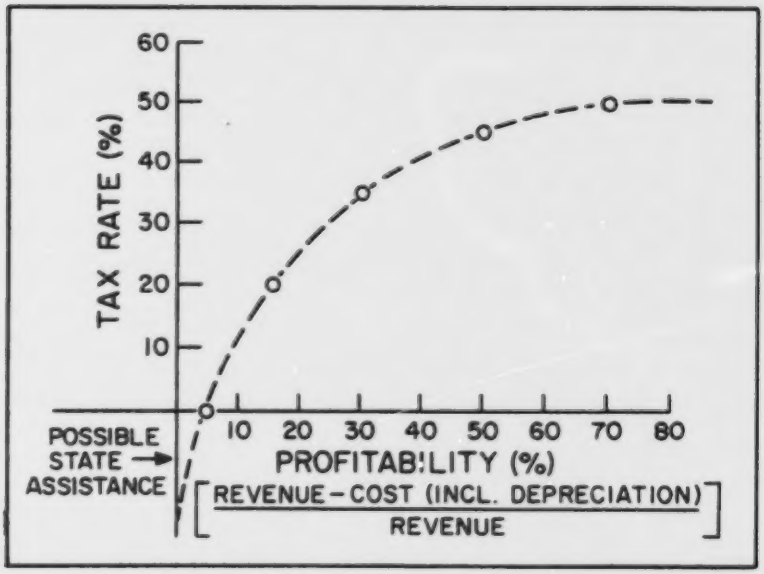

Figure 3. Sliding Scale Tax

The slide shows a possible sliding scale tax curve. Tax Rate is shown on the "y" axis and profitability on the "x" axis. Profitability for this purpose is defined as:

$$\frac{\text{Total Mining Revenue less Costs (including depreciation)}}{\text{Total Mining Revenue}}$$

Various examples are given in table 1.

Table 1

EXAMPLE OF EFFECT OF SLIDING SCALE TAX

				Sliding Scale Tax		Standard Tax	
Example	Revenue $	Costs $	Profit $	Rate %	Paid $	Rate %	Paid $
1	100	50	50	45	22.5	45	22.5
2	100	70	30	35	10.5	45	13.5
3	100	85	15	20	3	45	6.8
4	100	95	5	nil	nil	45	2.3

In example 1, when total costs (including depreciation) are half of revenue, then the tax rate under this possible tax formula would be identical to standard tax, i.e. 45 percent on profits, such that tax would amount in both cases to $22.5.

At 30 percent profitability (example 2), the sliding scale tax rate would fall in this example to 35 percent, compared with 45 percent under standard tax. Tax paid would decline to $10.5 compared with $13.5 under the standard rate system.

The differential increases at lower profitability. At 15 percent profitability (example 3) the tax rate drops to 20 percent, such that the tax paid is less than half i.e. $3.0 compared with $6.8 under the standard regime.

If profitability (as defined) falls to only 5 percent (example 4), that is to say, if costs (including depreciation) total 95 percent of revenue, then the tax rate is reduced to zero. Below 5 percent profitability, there is the possible provision of state assistance, either as tax rebates or even temporary subsidy.

Clearly this description is highly oversimplified. For example, the rate at which capital can be depreciated is not specified. In our opinion this should be entirely at the discretion of the company concerned and should be variable from year to year. No company investing in a mineral project should pay any tax until it has recouped its original investment.

It is appreciated that, in most countries, operating with a standard rate taxation system that includes capital allowances, inventory adjustments, etc. results in a taxation system approximating a sliding scale tax. Nevertheless, the proposed scheme has the advantage of simplicity. It is easily understood by both operators and the public, reducing the likelihood that politicians will get on the "windfall tax" bandwagon. In addition, such a taxation system is a clear recognition by government that taxing a highly cyclical resource industry must be done with great care to ensure the long-term healthy survival of a basic national asset.

Other areas where government can cooperate closely with the mining industry to ensure a better long-term future is the elimination of competition between local taxes, i.e. state and federal taxes. Equally important is the elimination of hidden taxation and excessive front-end taxation. In the latter case we refer to heavy ad-valorem tax, royalties on output, or export taxes. Hidden taxation usually takes the form of import duties on plant and equipment. If the power utilities, railways, harbours etc. are federal or state-owned, it can take the form of excessive charges, well above the world norm. The state of Queensland in Australia charges punitive freight rates to its mineral industry, double the actual cost of operating the railways. This has been a great cost penalty to the base metal operations at Mt. Isa and has made Australian coal appreciably less competitive, with consequent loss of sales, and probably an overall loss in total tax revenues for the state government.

Taxation should be based on the ability of the company to pay. It must be entirely based on profitability, taking full account of the need for large on-going capital investment.

Conclusion

In summary, grade trends, infrastructure, access to capital, security of supplies, and security of assets should be factors which favour investment in developed countries. In

developing countries, however, access to capital has been and will continue to be difficult for all but the most unique projects. I expect the World Bank to get more deeply involved in project financing in Third World countries over the coming years.

All great discoveries are made by men whose feelings run ahead of their thinking. And so the metals industry must meet the challenge of the existing and emerging group of industrial materials. The attack must be two-pronged. First, by continuing to reduce its cost structure through innovative thinking, by further reductions in energy, labour, and capital intensity. Second, the industry must be more aggressive in defending its markets and seeking new outlets under the umbrella of an overall strategic plan rather than by setting up ad hoc arrangements which have a tendency to protect and perpetuate empires.

"In almost all philosophy doubt has been the goad and certainty has been the goal", wrote Bertrand Russell in Portraits from Memory. And should the metals industry be thrust into renewed activity by these doubts about the future, then the goal of growth and prosperity will surely be attained.

STRUCTURAL CHANGES IN THE CANADIAN ZINC MARKET

John J.L. Davies

Canada is the world's largest mine producer of zinc. In 1984 it produced 1.2 millions tons, or 24.3 percent of the free world total of 5.0 million tons. This is down from the 30 percent level we enjoyed in the early 1970s. While production has remained quite static at current levels for some ten years, our percentage of the rising total has slipped. Australia, Peru, Mexico and the United States are our principal competitors.

Table 1

CANADA'S ZINC INDUSTRY

	1984	
	Metric Tons	Market Share
Zinc mine production	1,215,000	24.3%
Zinc metal production	683,000	14.0%
Zinc metal consumption	141,000	3.1%

In 1984 Canada's metal production totalled 683,000 tons, or 14.0 percent of the total free world production of 4.84 million tons. Unlike mine production, Canadian metal production has been increasing. In 1970 we produced 413,000 tons, or 10 percent of the world's total. Europe taken as a whole accounted for 39.6 percent, and is the world's largest single metal producer, followed by Japan with 15.4 percent.

Canadian zinc metal consumption in 1984 was 141,000 tons, or 3.1 percent of the total free world consumption of 4.7 million tons. Canadian consumption of zinc has remained static for ten years.

Table 2

MINERAL PRODUCTION OF CANADA, 1983

	Quantity	Value $ million
Copper (tons)	625,000	1,307
Gold (kg)	70,746	1,186
Iron ore (tons)	32,382,000	1,143
Zinc (tons)	971,000	1,116
All others		2,484
Total metals		7,238

The value of Canadian zinc production in 1983 was $1.12 billion, the fourth highest mineral value produced following copper, gold and iron ore. Exports were valued at $959 million. There are 14 zinc mines and 4 refineries that employ over 18,000 Canadians. By any measure zinc is a large and important business in this country. A careful look at this industry shows that the winds of change are passing over and sapping the vitality of former years. Its market lacks the sparkle and glamour of past years. A loss of vision and confidence about the future has eroded investments into new mines and in this is written serious implications about the future.

Change is the process by which the future invades our lives, and it is important to look at it closely. One way to measure change is to study the past to shed light on the present. Change has been with us from the beginning of time. It is fascinating to study, often difficult to accommodate and generally feared by all. Those of us who cope well with change seem to have a richer, better developed sense of what lies ahead of them than those who cope poorly. Hopefully, this seminar which is focused squarely on the changes affecting our mining industry will give us all a clearer perspective of the future.

The Belgians first identified zinc metal and its refining technology in the mid-18th century. Before the century closed and in the early stages of its industrial revolution, the U.K. discovered how to manufacture brass using Cornish calamine, and quickly acquired dominance of this industry, controlling both supplies and price. The industry prospered through the 19th century. By the early 1900s the centre of gravity of the zinc industry swung from

Europe to the United States, where industrial production was increasing and demand expanding exponentially. Being very well endowed with zinc and sheltered from the ravages of the European wars, the United States rapidly dominated production and price. The industry prospered and expanded through to the 1960s. At that time production peaked, costs rose, technical obsolescence set in, consumption faltered and once again the centre of gravity in the industry began to shift to other markets. Change has left its footprint on this industry throughout history.

Zinc is an industrial commodity and its markets are found in all countries with an industrial base. Historically there has been a close relationship between industrial growth as measured by GNP and consumption. During periods of high growth zinc consumption rises, and during recessions it falls. Because of its broad industrial use, zinc consumption has always been a sensitive indicator of the economic health of a nation. An examination of recent statistics shows that the ratio of zinc consumption per unit of GNP, often referred to as "intensity of use", for all the major industrial economies of the world has been falling, while this ratio is expanding in the developing countries. This is the first important measure of change in the zinc markets, and the causes are due to the following factors:

- The economies of most OECD countries are maturing. As they mature, the manufacturing component of the GNP shrinks relative to the service-oriented sector.

- Manufacturing methods are changing. Industrial technology has become more sophisticated with the growing use of the chip, and electronics use less metal.

- The efficiency of zinc usage has improved with time. This change has been forced on industry by rising costs, particularly for oil, and a desire to minimize the use of materials. Improved design and engineering technology has led to a reduction of weight. Small is beautiful!

- Intense and aggressive competition by sellers of competing materials has led to an erosion of the markets for zinc. The driving force behind the zinc industry has long been production. As a result its marketing skills have lagged.

During the massive reconstruction of Europe and Japan during the 1940s and 1950s, demand for all metals including zinc rose dramatically, particularly in the highly industrialized countries of the OECD as shown in table 3. However, as infrastructure development matured and the birth rate declined, the growth rate in metal consumption in these countries began to ease. Conversely demand began to pick up in non-OECD countries as governments in these countries financed massive programs to raise the standard of living of their citizens through industrialization.

Table 3

FREE WORLD ZINC CONSUMPTION COMPOUND GROWTH RATES
(percent)

	1950-73	1973-84	1980-84
OECD Countries			
Europe	4.62	-0.42	0.08
United States	1.75	-3.14	2.23
Canada	4.23	0.96	1.47
Japan	12.75	-0.50	0.59
Australia	3.75	-3.77	-4.54
Weighted average	3.63	-0.95	0.72
Non OECD			
South America	9.54	3.26	-2.70
South East Asia	10.69	7.21	7.81
Africa	9.23	2.87	0.48
Weighted average	9.96	2.20	5.05
Total free world	4.35	-0.26	1.22

This change has boosted demand for industrial metals and helped to sustain demand. As a result the driving force behind the markets for zinc is again swinging to areas of growth which now lie in the non-OECD countries.

Galvanizing dominates all market applications for zinc, accounting for 46 percent of the total. This market is

growing, partly because other applications have contracted but most importantly because the process has stood the test of time and proven to be the most cost effective method of protecting steel from corrosion. The process is well developed and requires little sophisticated technology. As a result it is widely used in developing countries and is the main thrust behind zinc's rising consumption trend in these countries.

New alloys have been developed to enhance the life of zinc coatings and to keep competing materials at bay. In response from car owners, automobile manufacturers are increasing their use of zinc-coated steel to improve durability from the ravages of salt corrosion. As a result, galvanizing lines in North America, Europe and Japan have operated at capacity for some time, and there is now a massive investment underway in building new lines, mostly using new electrogalvanizing technology.

Diecasting follows at 18.0 percent. This application has lost ground over the past 15 years due to substitution by aluminum, plastics and magnesium, a dramatic increase in imports, technical obsolescence in the diecasting industry and economizing through the introduction of thin-wall diecasting technology. While reducing the weight of a zinc casting, this technology has at least preserved a market. Consumption of zinc by the diecasting industry in the USA has fallen from 35 percent of the market to about 18 percent currently. Much of this change has resulted from the loss of zinc in the U.S. automobile, which has fallen from about 70 pounds per car in the late 1960s to 23 pounds today. The pressure to reduce the weight of the car is one cause for change.

Brass accounts for 19.0 percent of the market. Brass, an alloy of copper and zinc, is a widely used industrial metal having a low value-added component but wide end-use applications. Globally the industry has restructured into a few massive brass producers, mostly located in Europe and Latin America. These plants use the latest state-of-the-art technology to minimize their costs and have effectively forced most of the smaller, high cost, technically obsolete plants out of business. Many of the North American plants have closed so consumption of zinc by the brass manufacturers has fallen.

All other markets are small, reasonably secure from a technical standpoint and slow growing due to changes underway in the markets. For instance, about 7 percent of zinc consumption is used as oxide in the vulcanization of rubber - mostly tires. The steel-belted radials, which have doubled the mileage for tires and significantly reduced

demand for replacements, have obviously affected the consumption of zinc oxide used for this application.

Change always brings with it new opportunities. For zinc this has come from China. This country has announced a new long-term policy to expand its economic base to improve the standard of living of its citizens. The expansion of the infrastructure has begun, and this has turned this country from a modest exporter of zinc into a huge importer. China has turned to the West to meet its requirements of zinc and for the past three years has purchased over 200,000 tons of zinc per year, opening a massive new market for this metal. This new demand has been a lifesaver for the zinc industry.

A few words about the price of zinc might be useful, as price is always a sensitive measure of change. Figure 1 shows that a jump in price in both real and current dollars took place between 1973-74, coinciding with a rise in the oil price.

The most notable signs of change in figure 1 are the following. First, the price in current U.S. dollars averaged 13.8¢/lb. between 1950 and 1973, rising 180 percent to 38.6¢/lb. between 1974 and 1984. Coincidentally with this period, the average real price in 1984 dollars rose from 42.9¢/lb. to 53.1¢/lb. The price averaged 48.6¢ in 1984 and is currently 41.0¢/lb., or 22 percent below the last 10-year average. Between 1950 and 1984 the U.S. price averaged 46.1¢/lb.

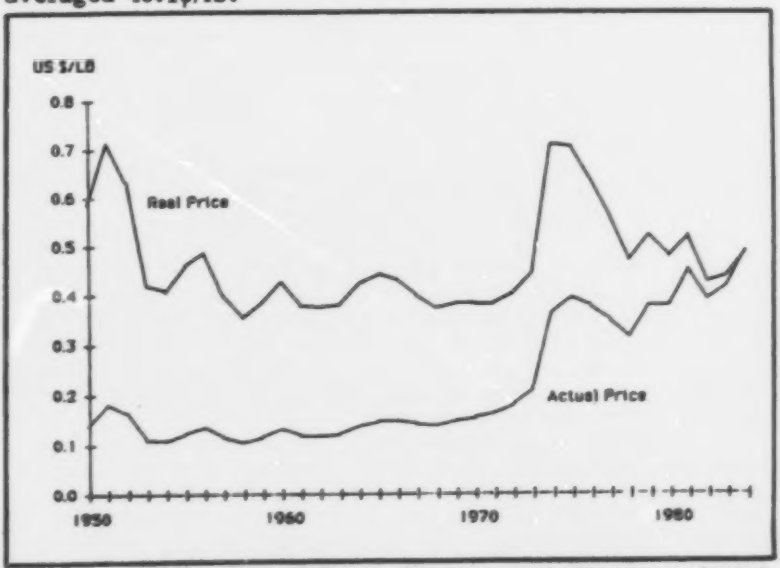

Figure 1. U.S. Zinc Prices, Current and Constant (1984) Dollars, 1950-84

Second, recent deflationary pressures in the market have wiped out the benefits of the real price increase experienced during the 1970's.

Producer stock changes are a sensitive measure of the supply-demand relationship in the market. When stocks rise, prices fall or vice versa. However, this long-term historical relationship seems to be changing: while stocks have been falling steadily since 1982, prices have performed erratically, rising initially with lower stocks but then falling even though stocks have continued to fall. Reasons for this apparent change include:

- the current high cost of money;
- perception in the markets that shortages are no longer likely;
- better management of inventories;
- widespread acceptance of switching, which reduces the pipeline;
- improved transportation services;
- increased consumer access to the global supply sources.

Zinc prices, particularly on the LME, are far more volatile today. Prices commonly change as much as 10¢/lb. in a month, an unheard-of swing ten years ago. Market information today is being transmitted around the world at an increasing speed. This information is available through computer terminals to a vastly expanding, "need to know" market. The result is that we now have a supersensitive market in which small changes in supply-demand relationships can and do lead to unrealistic price swings as the herd instinct takes over.

The relationship between price and currency values is a further factor that has affected the zinc price. The currency used to price zinc world-wide is the U.S. dollar. The result has been dramatic in those countries whose currencies have weakened against the dollar, with the price in some major consuming countries doubling over the past few years.

The treatment charge for zinc concentrate is fixed in U.S. dollars. This has provided a windfall gain for custom smelters located in those countries having weak currencies. As a result, most of the European custom smelters, who suffered years of serious financial losses, are once again profitable. In fact some are now beginning to plan expansions to their capacities.

A careful look at history will show that much of the changes we are experiencing in the zinc business date back to the early 1970s. The oil price increase in 1973 and

1974 was one significant factor. Higher fuel costs led to the downsizing of the automobile to improve fuel consumption through weight reduction. This in turn caused a massive change in demand for materials and labour. While it started with the automobile, the process of change flowed through to other industries. The net effect has been that a given standard of living no longer requires the same amount of zinc as it once did. The result is a classic case of structural change - an irreversible form of change that occurs periodically throughout history and which is often accompanied by social turmoil.

A large part of the rising prosperity and economic performance of the industrial world during the post-war period stem from the fact that real prices for many vital commodities declined. Lower real prices were due to:

- steady investments made into new technologies that reduced the processing costs, improved productivity and the passing of the cost benefits into the markets through price competition;

- the abundance of raw materials, which ensured that the spectre of supply shortages never became a serious reality;

- increasing the economies of scale by increased capital investments.

These factors spurred investment and growth in Canadian mine production, which rose from 280,000 tons in 1950 to a peak of 1.3 million tons in 1977. During the 1970s, a period of high inflation, prices rose but were offset by rising costs, higher taxes, Third World competition, shifts in markets due to closures of obsolete refineries, and a fall in new investment due to unsatisfactory financial returns. As a result growth began to falter. Although production has been maintained reasonably in line with the 1970 levels, Canadian mine production is now in a period of decline, both globally and nationally.

Canadian metal production has held up rather better. Our refineries have benefited from a long period of steady investment to modernize technologies, reduce costs through increased productivity and to comply with Canadian government policies of further processing. Most refineries are now cost competitive with the best in the world, and in addition have the added strength of downstream integration with mines.

There is convincing evidence today to suggest that the longest period of growth and prosperity the world has ever known ended in the late 1960s. Since that time almost every facet of life has been subject to accelerating change. A time of change brings with it uncertainties about the present while the future becomes increasingly more invisible. Zinc, like all metals, is passing through uncertain times due partly to structural change, which I have attempted to identify, and partly cyclical change. The net result has been painful to the business. However, it is reasonable to expect a return to prosperity will recur with an improvement in cyclical change, but structural change will be ongoing and probably intensifying.

The metal has a number of unique properties which industry has successfully adopted for the betterment of mankind. Some uses, such as galvanizing, have a proven record of success and have survived the test of time. The steel producers are the largest buyers of zinc and, although this industry is experiencing extremely difficult times which has resulted in widespread contraction and serious financial hardship to the industry, demand for coated steel products is on the rise. There is now considerable expansion under way in this value-added component of the steel business.

Rising demand for coated steels is not an unexpected occurrence. Consumers today have become more selective and demanding in the products which they buy. Having a greater choice available to them, consumers are seeking out products which have design and quality excellence. The throw-away mentality so prevalent in our society a few years ago is rapidly disappearing, perhaps as a result of rising affluence and the aging society. Zinc adds quality to steel and thus has benefited from the present trend towards quality. I say present because there is no certainty that the future is secure. Nothing today is; and unless an industry is prepared to defend its markets with vigorous promotion and ongoing market development, substitution by competitive materials is a distinct reality.

Zinc's use in die castings is under fierce attack. It has lost an important share of this market and although the metal has superb engineering properties and castability and is truly hard to beat as a die-casting material, it is unlikely to recapture the markets it has lost. The contraction in the business has meant a large loss of people who sell zinc castings, fewer die casting machines available, a loss of technology and skills available to the industry, and some loss in confidence. Retaining the status quo for this mar-

ket will require new technology, new alloys, new investments and the development of new marketing skills - a commitment which I believe the industry will make.

Change has affected some of the other important markets for zinc as mentioned earlier. However, chemicals and related products offer some of the best growth opportunities based on the unique cost effective properties of this metal. An example of a recent success was zinc's acceptance in 1982 by the U.S. Mint for the manufacture of the U.S. penny. As a result, in 1984 the Mint purchased over 45,000 tons of this metal, which was rolled into sheet, stamped into 1¢ blanks and coated with a thin layer of copper before being faced.

A bit of trivia for those interested: There are 181 pennies to a pound of zinc, or 362,000 to the ton. The Mint report that 92 percent of all 1¢ pieces that are placed into circulation disappear immediately after introduction, probably into piggy banks. Stamping 1¢ pieces out of zinc has thus become a unique and valuable market for this metal.

The driving force behind any business is its markets. If the markets are changing, the business has no alternative but to change with them. Canada's strength in zinc lies in its mine production, partly because the country is well endowed with this mineral and also because of our expertise and great mining culture. During the long period of economic prosperity, the zinc industry grew and prospered. In recent years, however, it has become quite fragile, being burdened with high and rising costs, declining ore reserves, unsatisfactory financial performance and almost a total lack of new investments. Its viability is waning and it has started to lose some of its former importance in the market. Zinc is no longer a growth industry in this country. However, judging by existing investments, we will continue to play a key role in the industry and unquestionably should expect some return to prosperity of former days.

A strategy for survival should include the following measures:

- Canada should not seek to expand its mining base unless high rates of return are possible;

- cost management must become the highest priority of any company with realistic prospects of survival - rising costs are a serious problem;

- higher prices are not the answer to rising costs since they give rise to substitution and shrinking markets;

- new technologies aimed at reducing unit costs of mining and higher metallurgical recoveries must be developed if zinc mining in Canada is to remain competitive and economic;

- all levels of government must resist pressures for subsidies to the industry. Subsidies discourage excellence by supporting the weak;

- industry's philosophy must change from production driven to market driven enterprise. Demand for zinc can only be increased through technology transfer and innovation in new products, developed in the research laboratories and brought into the market, along with the promotion of existing markets.

THE WORLD POTASH INDUSTRY - CHANGES IN SUPPLY AND DEMAND

Douglas A. Karvonen

Introduction

Potash is a general term used to describe a large number of potassium-bearing materials. A few of these materials, which occur as soluble salts in bedded underground deposits or as brine in lakes or in seabeds, account for all of the potash produced for use in agriculture and industry.

About 95 percent of potash produced is used as a fertilizer in agriculture. Potassium (K), along with nitrogen (N) and phosphorus (P), makes up the three basic elements necessary for healthy plant growth. The remaining 5 percent of potash is used in industry, initially converted to caustic potash (KOH), which becomes a basic chemical building block necessary in manufacturing a wide variety of products including dyes, paints, insecticides, soaps, television tubes and batteries.

More than 90 percent of potash used in agriculture is produced in the form of potassium chloride or muriate of potash. Most of the remainder is in the form of potassium sulphate or potassium magnesium sulphate. The agricultural potash is manufactured in a variety of sizes and colours depending upon the market and ultimate blending process (either bulk blending or granulation) used to combine it with nitrogen and phosphorus based products. The colour, ranging from red to white, depends on the natural colour of the ore as well as the procedure used for refining. Agricultural grade potassium chloride is generally 95 percent pure or better while the chemical grade is greater than 99 percent.

Scientists decided years ago to express the potassium content in terms of K_2O equivalents and so most potassium products are graded and sold on this basis. Pure potassium chloride is 63.2 percent K_2O and agricultural grades are therefore generally a minimum of 60 percent K_2O. (To convert tonnes of K_2O equivalent to actual product tonnes of KCl it is necessary to multiply by 1.58; conversely, it is necessary to multiply KCl tonnes by 0.632 to get K_2O tonnes.)

Most of the potash produced in the world is first mined conventionally either by blasting or by mining machines. After being hoisted to the surface it is refined

by a series of steps involving crushing, flotation (a wet mechanical process where potash is floated off from the waste, which is largely sodium chloride), centrifuging, drying and screening. Fines are usually dissolved and recrystallized either as separate products or blended with floated products.

Solution mining, by dissolving potash beds with heated brine, is utilized as a production technique by one mine in Saskatchewan (Kalium Chemicals, a division of PPG Industries Canada Ltd.). After the brine is pumped to surface, evaporation and crystallization techniques are used to produce the finished products. This process can be used where beds are too deep to mine conventionally. However, energy costs are a large component of processing costs because of the need to evaporate all the water. The evaporation/crystallization route is used in other parts of the world, such as in France and the Soviet Union, as a refining technique even though the ore is mined conventionally.

The lake brines can be a source of potash in certain parts of the world where the potassium content is high enough. For example, Arab Potash Company in Jordan and Dead Sea Works Ltd. of Israel produce potash from the Dead Sea by using the sun, initially to concentrate the brine in ponds, followed by flotation and crystallization. Similar methods are used by Great Salt Lake Minerals in Utah. Other potential sources of lake brines exist, although they are not large in number. One such lake (Lake Cha-erh-han) in northwest China will likely become a more significant producer in the late 1980s or early 1990s. Electrostatic separation of dry ore is also practised as a refining technique in West Germany.

Known world potash reserves are plentiful.[1] Estimates have placed Saskatchewan's underground reserves alone as adequate to meet world demand for more than one thousand years. Saskatchewan has been estimated to have more than 40 percent of world reserves. Large underground reserves also exist in the Soviet Union. Although less extensive, substantial underground reserves exist in East and West Germany. France, Italy, Spain, the United States, the United Kingdom, Chile, and New Brunswick in Canada all have deposits that are worked for various potassium salts. Substantial reserves are contained in the Dead Sea brines and the brines of Great Salt Lake. Searles Lake and the

1. United States Department of the Interior, Bureau of Mines, Mineral Commodity Summaries - 1985 (Washington 1984).

Great Salt Lake Desert in the United States and the salt lake in Qinghai province in China make up the rest of worked sources. Manitoba in Canada could potentially become a source of potash as a result of reserves which are an extension of the Elk Point basin, and are similar to those mined in Saskatchewan.

Altogether, about 18 sources of potash in 13 countries are being worked.[2] Potential potash reserves, yet unmined, have been discovered in a number of locations around the world including Australia, Botswana, Brazil, Chile, Egypt, Ethiopia, United States (Michigan), Saudi Arabia and Thailand. Some of these will become producing areas during the next decade.

Production

The discovery of potash salts in Germany in about 1840, followed by a recognition of the need for potassium in plants, led to the birth of a modern potash industry in 1861.[3] In two years, the number of plants had increased to 14, and by 1900 over three million tonnes of salts were being extracted. During the early 1900s, potash was also discovered in France and after World War I, French and German companies competed quite aggressively for world markets. Declining prices and profits led the German producers to form a cartel, with the result that they were able to maintain profitability and firm prices.[4]

This first phase in world potash production is characterized by a period of fairly rapid growth, a few suppliers working as a cartel, and stable prices. During the early 1920s the number of active mines operating in Germany was reduced while production continued to increase. Production from Germany reached one million tonnes K_2O in 1927.

What can be designated as the second stage in the development of the world potash industry began in the late 1920s and early 1930s with the first production of potash from Spain, Palestine, Poland, Russia and the United States. Initially production from these new sources was quite small, but as it grew it had its effect on world

2. British Sulphur Corporation, The, World Survey of Potash Resources, Fourth Edition (London, 1985), xiv.
3. World Survey of Potash Resources, xiii.
4. W.E. Koepke, Structure, Behaviour and Performance of the World Potash Industry, Department of Energy, Mines and Resources, (Ottawa 1973) pp. 74-80.

prices. During this period, arrangements were made with the cartel in Europe and prices were stabilized. The world-wide depression and World War II interrupted the production of world potash. With Germany divided after World War II, the United States became the world's largest single potash producer. Most of the U.S. production was concentrated in the Carlsbad, New Mexico area. The emergence of new potash producers in a number of scattered geographic locations and the decline in the influence of the German/French cartel during this period can be considered a significant turning point in the world potash industry. When the United States emerged as a major producer of potash, along with growing demand in North America, the concentration of the industry shifted away from Western Europe.

During oil exploration in the early 1940s, potash was discovered in the province of Saskatchewan, initially at a depth of some 7,600 feet, and later at shallower depths. Until 1951, the Government of Saskatchewan was able to elicit little industry interest in the potash reserves. An early attempt at shaft sinking in 1952 was a failure because of technical and financial difficulties and the project was abandoned due to flooding.

A second attempt was made by Potash Company of America, a New Mexico producer. This attempt was more successful, and in 1958 the first potash ore was hoisted from a mine in Saskatchewan. This mine was later forced to close because of water seepage. It took another six years before it reopened, but it remains in production to this day.

Another company, International Minerals and Chemical Corporation, began attempts to sink a shaft in 1957, and in 1962 the first continuous production of potash from Saskatchewan began.

These early [illegible] presented significant technical challenges to the [illegible] Saskatchewan potash producers because of the [illegible] difficulties encountered in shaft sinking through a [illegible] pressure, water-bearing formation known as the Blairmore. While other conventional potash operations that followed experienced some difficulties in shaft sinking, none of these were as severe as those experienced by the first three companies.

By 1970, the Saskatchewan potash industry consisted of ten active potash mines, nine of which were conventional operations and one a solution mine. The ownership of these properties was made up of three categories: those producers which had operations in the Carlsbad area of New Mexico; one company which was owned by French and

German interests; and the third category made up of new entrants which previously had not been involved in the potash industry.

During the 1960s potash production of commercial importance was developed in Italy and the Republic of Congo. Italy still remains a producer, but the mine in the Republic of Congo was forced to close in the 1970s as a result of water seepage.

In 1974 a mine came into production in the United Kingdom. During the early 1970s production expanded quite rapidly in the USSR with major increases from the Byelorussian Republic as well as the Urals region. During the late 1970s, several expansions were made at the mining and refining operations in Saskatchewan.

The Potash Corporation of Saskatchewan, a Saskatchewan provincial Crown corporation, was formed in 1975 and in 1976 began a process of acquisitions. These acquisitions, which took place between 1976 and 1978, resulted in the corporation acquiring approximately 40 percent of the productive capacity of the province, giving the corporation sole ownership of three potash mines, 60 percent ownership and operating responsibility for a fourth, and acquiring ore reserves and a production agreement for about 25 percent of the production from two mines of International Minerals & Chemical Corporation (Canada) Limited. The acquisitions followed a long period of negotiations and legal actions surrounding regulations and taxation levies established by the government of the day.

With the expanding markets of the late 1970s, PCS proceeded with expansions at four of its five divisions. Additional expansions were planned which included a new greenfield potash mine. However, the world-wide recession and downturn in potash markets in 1981 forced cancellation of these additional projects.

During the late 1970s some minor expansions were also made by the mines owned by the private sector in Saskatchewan. All of the expansions by PCS and other companies operating in Saskatchewan (with the exception of the PCS Mining Rocanville Phase II Expansion of approximately 600,000 tonnes KC1 completed in 1981, and the Lanigan Phase II Expansion of approximately 2 million tonnes KC1 which will be complete in 1985) have been of the bottlenecking-type of between 150,000 to 400,000 tonnes KC1 per annum. The productive capacity of the Saskatchewan industry is presently about 13.7 million tonnes KC1, or 8.3 million tonnes K_2O and this capacity is owned by seven companies, which represents approximately 28 percent of the world's productive capacity. Industry sales grew to more

than 7.0 million tonnes K_2O with a value of about $1.0 billion in 1980. Some decline in sales and revenues as a result of the world wide recession have taken place since then although there has been a recovery in 1983 and 1984 (figure 1).

In the 1980s several new regions came into production, in addition to expansions in Saskatchewan, the USSR and Israel. These are Jordan with production from the Dead Sea brines and the province of New Brunswick with two conventional mines which are both still in the start-up phase. A project in Brazil is scheduled to begin production in 1985.

In 1984 world production was about 29.5 million tonnes K_2O. The following is an approximate breakdown: USSR 33 percent; Saskatchewan 26 percent; East Germany 12 percent; West Germany 9 percent; France 6 percent; United States 5 percent; Others including Israel, Jordan, China, Latin American, Spain, Italy, and the United Kingdom 9 percent.

What could be described as the third period of major change in the world potash industry was the beginning of the Saskatchewan potash industry in 1962, followed by the fairly steady and rapid increase in production up to 1981, which could be considered the end of the period. During this period Saskatchewan producers became major factors in world export markets as 95 percent of all Saskatchewan potash is exported outside of Canada.

Probably 1981 marked the beginning of the fourth period of structural change for the potash industry. It has been characterized by fluctuating production rates, resulting from unstable world markets, as well as the entry into the industry of new producers in Jordan, New Brunswick and most likely, Latin America. Resources have been discovered in many parts of the world and while some of these deposits will be difficult to develop, plans for their exploitation continue. Some of these discoveries are in less-developed countries where governments are very interested in seeing these developments, in some cases for the foreign exchange earnings that might be saved by domestic production of a vital resource, but often as not for the foreign exchange to be made.

World potash production, which grew at an average rate of about 7 percent per year during the 1960s and 1970s, has shown very little growth in the 1980s. In fact, world production fell about 12 percent in 1982, recovering to a new record in 1984. Capacity increases, based on forecast growth rates for demand which were much higher and planned for the late 1970s, are presently coming on

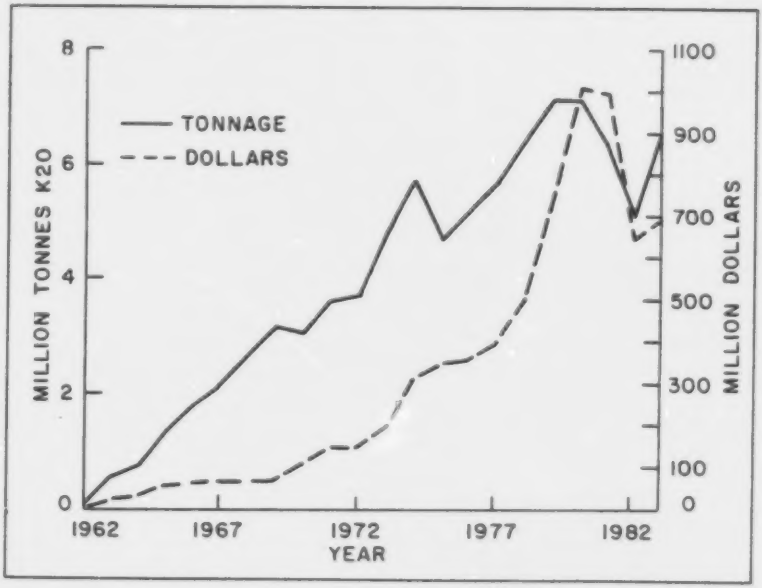

Figure 1. Saskatchewan Potash Industry Sales, 1962-83

stream. Production capacity is likely to continue growing at 5 to 6 percent a year until 1988 when most of the expansion plans now committed will be completed and available.

Demand

During the first two stages in the development of the world potash industry, demand was largely centred in Western Europe. Eastern Europe and North America began to emerge as markets in the 1930s. It was not until the latter part of the second period, during the 1950s, that the early signs of export potential in Asia (Japan) became apparent.

Throughout the first two periods and until the mid-1960s, demand was adequate to take all of the production available. The two World Wars created disruptions, of course, but available information suggests that the industry was profitable during this period.[5]

During the 1960s the Green Revolution resulted in a steady 6 to 7 percent per annum growth rate in world potash demand. The growth rate continued on into the 1970s at a fairly consistent rate except for some disruption created by the OPEC oil crisis in 1973. With the exceptions of Western Europe and Japan, which began to show signs of becoming a mature market during the early 1970s, demand grew in most regions of the world.

While demand growth was strong during this period, a severe oversupply developed in the late 1960s because of the sudden expansion of capacity in Saskatchewan. In 1969 the Government of Saskatchewan brought in a potash prorationing program in an attempt to halt the sliding prices and regulate production. The program had the desired effect of raising prices and was operated for approximately three years until potash demand began to catch up to production capacity and the program was disbanded. The recovery in potash prices placed against a background of rapidly rising oil prices and general upward revisions to resource taxation in several parts of Canada resulted in the Saskatchewan government applying a taxation levy called a Reserve Tax in an attempt to capture a portion of these new revenues. Although modifications were made to the tax and royalty scheme in the late 1970s, the modified system (called the Potash Resource Payment Agreement) is still in effect. In 1983/84, it raised approximately $40 million in

5. Structure, Behaviour and Performance of the World Potash Industry, pp. 48-51.

revenues for the provincial government. This payment is quite sensitive to potash price and the revenue collected by the provincial government is down substantially from the period of peak prices in 1980 and 1981.

By 1981, the impact of the world wide recession and the huge grain surplus in the United States resulted in the U.S. government bringing in an acreage reduction program called "Payment in Kind" which resulted in a dramatic drop of nearly 20 percent in potash sales to North America in 1982. This event and the world wide recession signalled an end to the generally even growth which had been experienced in world potash consumption.

Because of the weak demand in the USA and the financial problems of Latin America, there was no growth globally between 1978 and 1983. Although 1984 appeared to set a new record at about 28.3 million tonnes K_2O, the current outlook is not very encouraging. Broken down by region, demand in 1984 was as follows: East Europe 36 percent; West Europe 22 percent; North America 21 percent; Asia 12 percent; Latin America 6 percent; Africa 2 percent; and Oceania 1 percent.

Structural Change During the 1980s and the Future

So far, this paper has devoted considerable attention to describing the world potash industry and the major events which have in the past signalled the beginning of permanent change. The rest of the paper will attempt to describe the present period which began in 1981 and project where the industry is heading.

Simply stated, the situation facing the industry today is difficult. It includes the following:

- an economic crisis in North American agriculture;
- a heavy debt load and weak purchasing power in less-developed countries;
- a growing tendency towards countertrade;
- oversupply of potash resulting from demand forecasts that were too optimistic, aggravated by totally new supply sources which must develop their own distribution channels;
- a rising interest in protectionism in the United States.

North American agriculture is itself in a period of major structural change. Grain producers are facing a very competitive market as a result of increasing exports from the European Economic Community, Argentina and Aus-

tralia. Meanwhile, countries that used to be major importers, such as India and China, no longer require grain because of the success of their own agricultural policies and could, in fact, become an export threat. The result is a flattening out and perhaps even a drop in grain trade while more suppliers become a factor.

Domestically, a switch away from beef, veal and pork consumption toward poultry and fish means weaker demand.

Weak prices and volumes, coupled with a high debt structure from investments in farm assets at inflated prices, have meant that net farm income, as well as gross income, has dropped dramatically from the 1970s. Uncertainty surrounds the nature of U.S. farm support programs which have become a costly drain on the treasury without producing the healthy farm economy which was their objective. Indications are that a large percentage of farms in the USA will go bankrupt and that perhaps 20 to 30 percent of land will be taken out of production.

The United States accounts for 55 to 60 percent of Saskatchewan potash sales and the Saskatchewan industry has about 75 percent of the market. This potash is used largely to grow corn and soybeans. Fertilizer consumption is likely to drop at least 5 percent with zero growth for several years even though more productive land will be farmed more intensively. Without unforeseen events, U.S. potash consumption, which represents 95 percent of North American consumption, is likely to plateau and unlikely to recover to the record of 1979 until the middle of 1995.

Offshore, the situation is varied although only slightly more optimistic. Western Europe is a mature market likely to show little overall growth. Eastern Europe has more growth potential but is unavailable to non-East European producers because of the production in East Germany and the USSR, both of which are net exporters to most markets available to other producers. Africa is unlikely to provide much in the way of growth because of political instability and lack of strong agricultural development policies in most areas. Oceania is a small market and its technology is well developed so that a small growth rate will have little impact on volume.

That leaves Latin American and Asia as the major growth areas. Cuba and Brazil are the major markets in Latin America. Cuba is largely locked into East European suppliers. Brazil represents about 65 percent of the market in this region and has good growth potential. Consumption grew quickly in the late 1970s, but the debt crisis brought this to a halt in 1980. A major drop in consumption took place between 1981 and 1983, with some recovery

in 1984 and 1985. A new potash mine will eventually meet some of their own requirements. It remains a very competitive market, with GDR being the base supplier through bilateral trading relationships and favourable financing. Growth in Brazil could be in the order of 8 percent per annum with perhaps 6.5 percent for the region as a whole during the next decade. Its financial problems have not yet been totally resolved.

The other growth market is Asia. India has emerged as the largest market and the country with the most stable growth rate. Japan is a stable market, but it has no growth potential because its agriculture is likely the most intensive in the world.

China appears to have the largest volume potential of any country in Asia. While its apparent consumption rivaled India's in 1984, it has yet to become a steady growth market as its purchasing pattern over the last decade has been very erratic. For example, it purchased most of its needs from Canada in 1984 with some 700,000 tonnes KCl. In 1985 it has not purchased anything. Considering that such a sale represents a 65-percent operating rate for a typical Saskatchewan mine, China's absence as a buyer is significant. Other markets in Asia with growth potential include Indonesia, South Korea, Malaysia and the Philippines. As a whole, Asia should grow at 4.5 percent per annum during the next decade, recognizing that the overall growth rate will depend on China.

The debt crisis and lack of foreign exchange facing some of the countries in Latin America and Asia have forced them to adjust their agricultural policies negatively, as well as reduce purchases except under the most favourable financing terms or countertrade.

Countertrade can take place in several ways. It can be conducted under a bilateral trade agreement between countries, a method which has been used by East Germany; through tenders involving both purchase and sale of commodities, as has been the case with Indonesia; or it could be a preference for suppliers that purchase quantities of the buying country's goods, as recently introduced by India. Regardless of the mechanics, it is a growing factor in world trade.

One of the problems which has been a continuous issue since the mid 1960s is oversupply created by expansion of the world industry based on forecasts which have always been too optimistic. Hopes for the Green Revolution, which led to the potash oversupply of the 1960s, never materialized and the capacity installed was not utilized until the late 1970s. Expansion plans initiated during the latter

period, coupled with a drastic cutback in demand estimates for the 1980s following the recession, mean that the industry will be in a serious state of oversupply until at least the early 1990s. If new supply sources now planned in some of the developing countries as well as Manitoba, New Brunswick and Michigan proceed, the oversupply situation will continue well into the 1990s.

A review of world supply/demand estimates suggests caution in basing expansion plans on estimates more than five years into the future (figure 2). There is no historical basis to believe they will be anything but optimistic. Indeed, the FAO/World Bank Working Group estimates, which form the basis for many forecasts, should be regarded as optimistic by definition, given that their objective is to ensure adequate supplies of fertilizer are available to maximize world food production.

Once new supply sources are on stream they remain there until costs cannot be recovered over a period of time. The length of this period will depend on the financial resources of the owner and its view of the future. As a large proportion of the world potash industry is state owned, the timing of closure can be further complicated and is difficult to predict. New supply sources in the current environment will also have a destablizing effect on prices.

Protectionism in the USA is also a threat to free trade in potash. The U.S. producers in New Mexico, with ore deposits and costs higher than those experienced by some other producers, have been under pressure since the mid-1960s. Several producers have closed or cut back operations and today production is about one-half that in the early 1960s. During the last year, all of the operations except one have been available for sale or have changed ownership, a clear indication that their current or previous owners do not anticipate improvements in the future.

This threat to the U.S. industry has resulted in a number of initiatives designed to delay closures or protect the remaining industry. These steps include attempts by ad hoc committees organized by the City of Carlsbad, New Mexico to investigate possible action that might be taken; Congressional public hearings chaired by Senator Domenici of New Mexico; and petitions to the U.S. Department of Commerce and International Trade Commission by two Carlsbad area producers for imposition of anti-dumping and countervailing duties against potash from Spain, GDR, USSR and Israel. While the results of these actions so far have been minimal, they, along with similar attitudes by the USA toward other imported commodities, suggest yet another risk for the world potash industry.

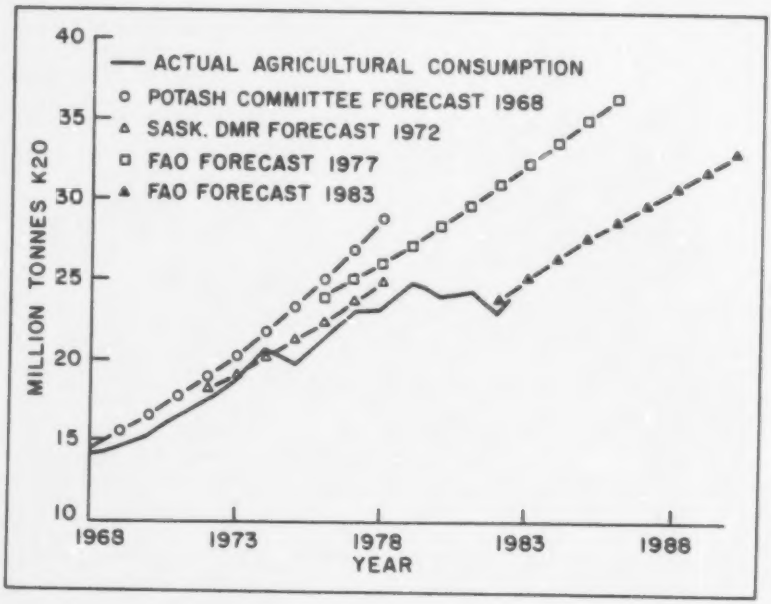

Figure 2. Forecast vs. Actual Potash Consumption, 1968-90

Conclusions

A number of conclusions can be drawn from a review of the present situation.

1. The potash industry will be forced to rationalize or close production capacity to deal with the overcapacity. This should be the high cost producers, but may not be because of protection provided.

2. Until rationalization of production takes place, weak prices will prevail. North American prices in current dollars are as low today as they were during the mid-1970s. Producers outside of North America are benefiting from a strong U.S. dollar which is insulating them from a cost squeeze.

3. Potash demand will again fall short of current estimates of expected demand (figure 3). A demand growth rate for the next ten years of 2 percent per annum is probably realistic. The period of oversupply therefore will be longer than anticipated.

4. The world industry will be under extreme pressure to reduce costs. New suppliers will find entry into the market difficult even if they can meet the unlikely criteria of accessible, high quality reserves, superior technology and close proximity to growth markets. This last condition is very significant because potash is a low-value bulk commodity for which transportation can make up as much as half the delivered cost. A look at freight rates and FOB mine netbacks in Canada suggests that railways have been much more successful at maintaining a price structure to recover increasing costs than has the industry (figure 4). Freight costs must be kept low to maintain a competitive industry.

5. The potash industry in Saskatchewan has the ability to expand its capacity at one half to two-thirds of the cost of a large greenfields project with less lead time. When capacity is required, it can be added at most of the operations in the province in small increments. New technology will enhance this ability. New potash projects, at least in Canada, cannot be justified in the foreseeable future on a normal rate of return basis.

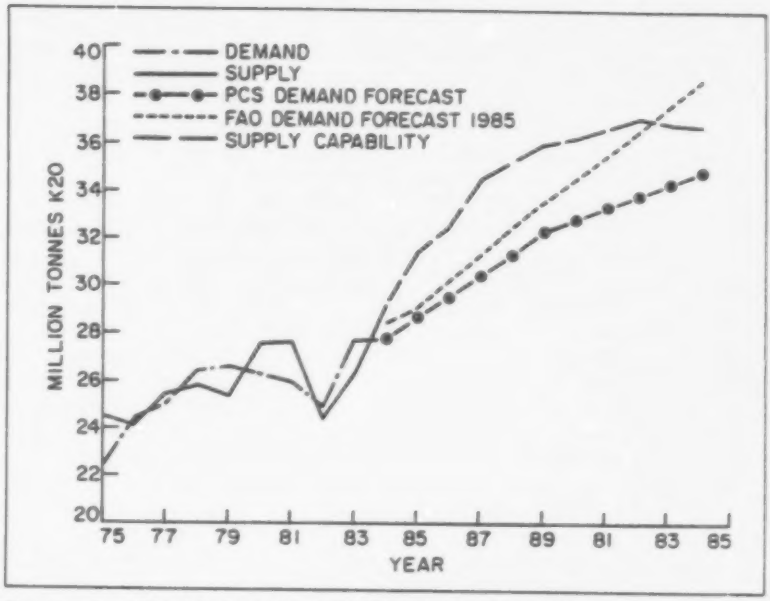

Figure 3. World Supply and Demand, 1975-95

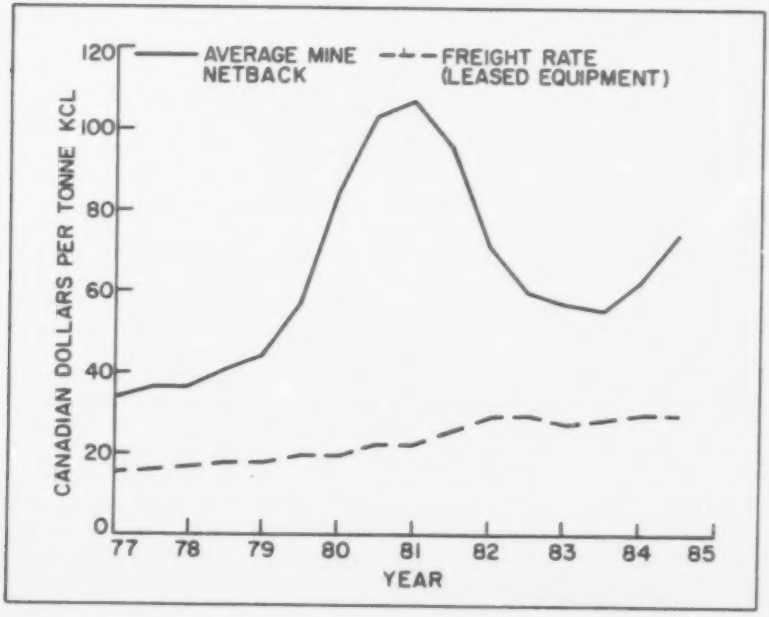

Figure 4. Saskatchewan Export Netbacks vs Freight Rates to Vancouver, 1977-85

6. The new economic environment means the Canadian industry must learn to compete more aggressively in the global market. New markets must be developed and serviced. For example, this may mean that countertrade will become an increasing part of conducting business. CIDA funding has been of great assistance in developing markets in India, Sri Lanka and Indonesia. CIDA's participation in an agronomic development program jointly with the Government of Saskatchewan and the industry to demonstrate the benefits of potash in China will ultimately result in more consumption. Such funding must be continued.

   Saskatchewan potash is sold offshore through a producer-owned company called Canpotex Limited which provides good sales and transportation economics to the industry. To survive and grow this company must be aggressive in its sales program and accommodate the more complex environment of the present. A customer's needs must be met. The alternative is not to be in business.

7. Finally, governments must be careful not to place too many demands on the industry for economic rent. At least in Saskatchewan, these expectations have always been high. A number of economists have attempted to determine whether the rent has been maximized.[6] While the debate is interesting and the revenues raised have been substantial, the possible negative implications for the long-term health of the industry and growth potential cannot be overlooked. It may be that the payments extracted are too high and that as a result jobs and investment are lost.

In summary, the world potash industry is at the beginning of a fourth period of structural change since its beginning. The industry, at least in North America, is presently having difficulties. With a more aggressive marketing effort, some attention to the errors of the past and a strong program for R&D and development, it will emerge stronger. This is particularly true for Saskatchewan which has the reserves to meet demand for at least a thousand years.

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6. David L. Anderson, Discussion Paper No. 264, The Saskatchewan Potash Industry: Alternative Strategies for Future Development, Economic Council of Canada (Ottawa 1984).

THE IMPACT OF TRADE POLICIES ON CANADIAN MINERALS

Germain Denis

Before narrowing the focus down to minerals, it is worth taking a little time, I think, to set trade policy into a more general Canadian perspective. The bottom line is that trade and trade policy have contributed significantly to Canada's development as a nation and to the evolution of our economy into one which is modern, diversified and well integrated into the world scene.

The Role of Trade Policy

Throughout the post-war period, Canada's trade policy has been consistently oriented toward seeking improved access to larger markets for Canadian goods and services. This, in turn, has encouraged a substantial degree of international specialization and provided for a more competitive and stimulating environment within the Canadian market. Overall, as a fall-out from Canada's participation in seven post-war rounds of trade negotiations under the General Agreement on Tariffs and Trade (GATT) and various other initiatives, Canadian producers now benefit from very significant opportunities to increase their productivity through sales, not only in the relatively limited Canadian market, but also in the USA, Japan, the European Community and the rest of the markets of the world.

But trade policy is not simply a matter of opening up markets to the freer flow of goods and services. However important that aspect may remain, trade policy plays other roles. Market access, once achieved, needs to be secured or safeguarded. The GATT itself plays a very significant role in this regard, as do the various nontariff barrier agreements negotiated under GATT auspices. Bilateral trade relations and initiatives that enhance them are also important players. An effective trade policy also looks at ways of improving the functioning of the international marketplace, and of dealing with any distortions to competition which may exist or arise. Finally - and of periodic direct relevance to metals and mineral producers - trade policy considerations play a significant role in the regulation of either injurious imports or strategic/sensitive exports.

The Significance of Resource Sectors to Canadian Trade Policy

Exploitation and transformation of the products of Canada's resource base - whether the sea, the soil, the forests or the mines - has consistently been a foundation for industrial development. The development of export markets has been a priority concern over the years in the conduct of Canada's trade relations with many other parts of the world, but especially the USA, Japan and Western Europe.

This is particularly the case for ores, metals and the processed or fabricated products of our mineral endowment. The strong export orientation of the metals and minerals industry in Canada has meant that, along with agriculture, fisheries and forest products, the resource-based sectors have had a determinate influence on Canada's position in trade negotiations in particular, and trade policy approaches more generally.

Canada remains among the world's largest exporters of aluminum, nickel, zinc, asbestos, molybdenum, gypsum and platinum. Exports of metals and minerals still exceed 20 percent of total Canadian exports; Canada also imports important quantities of minerals such as bauxite, coal and iron ore for use in the iron, steel and aluminum smelting industries.

Something in excess of 80 percent of these Canadian mineral exports is in the form of crude materials and primary metals, and it is not surprising that industrial diversification and development aspirations of various regions and communities across the country are tied to the prospects of raising the level of production of these resources in Canada.

The 1960s and 70s saw an erosion of Canada's overall share of several world mineral commodity markets. Through the 1980s the supply/demand balances may begin to be restored as economic recovery occurs, but slower international rates of economic growth seem to hold the promise of only modest growth of world consumption of metals and minerals.

Canadian producers can nevertheless be expected to remain a major factor in international mineral commodity markets, particularly for nickel, copper, zinc and aluminum. Similarly, Canada may be expected to become an important factor in the world thermal coal market.

Canada's favourable resource base and reputation as a politically stable and reliable supplier of resource commodities should serve Canadian producers well in maintaining their shares of world markets. Moreover, although overall world supplies for major minerals may be relatively abund-

ant in present economic circumstances, major industrialized countries remain heavily dependent on imports of industrial raw materials and concerned about ensuring stability and security of their supplies.

During the 1973-79 Tokyo Round of multilateral trade negotiations, metal and mineral products received high priority attention from Canadian negotiators. The results, while perhaps less far reaching than had been hoped at the outset, were nevertheless a very considerable accomplishment. Overall, looking at the average for all major industrialized countries (Canada included), the tariff rates on metal semi-fabs, for instance, were negotiated downward by about 30 percent. Coupled with similar results from previous negotiating rounds, this means that such rates now average below 5 percent. For articles of metal, the average residual protection in industrialized countries is now around 6 percent, down from almost 10 percent at the start of the Tokyo Round. There was also some success registered in bringing nontariff measures under better discipline and in reducing or eliminating their impacts.

Just as averages and generalities mask the reality of a particular duty rate which stands as a barrier to shipments of a particular product, so some of the specific accomplishments of past negotiations fade into the recesses of memory. People forget, for instance, that an important reason behind Canadian ores, concentrates, potash, sulphur, and many fertilizers moving essentially unimpeded by tariff barriers is that duty-free access was bought and paid for in the course of earlier negotiations. It is, I think, also worth recalling some of the specific concessions agreed upon during the Tokyo Round and right now in the final stages of being implemented. The U.S. rate on aluminum ingot, for instance, was negotiated to "free". The USA also agreed to cut its tariffs on most asbestos products to "free". Its rate on magnesium ingot, 20 percent at the outset, will reach 8 percent after the end of next year. The tariff on the main manufacture of gypsum (i.e., wallboard) was also agreed to be cut by 60 percent and will be less than 2.5 percent after the end of next year. The USA also agreed to reductions in the area of 40 to 50 percent for such semi-manufactures as pipe, bar, rod, plate, sheet, etc., most of which will face duties in the 4 to 7 percent range after the end of next year. There were also some less striking reductions agreed to by the European Community and Japan. Canadian exporters of semifabricated nickel, aluminum and copper products to Europe will now face duties in the 4.5 to 10 percent range, down from the 6